place a 1-cent stamp on this notice, hand same to any postal employee, and it will be placed in the hands of our soldiers or sailors at the front. No wrapping; no address.
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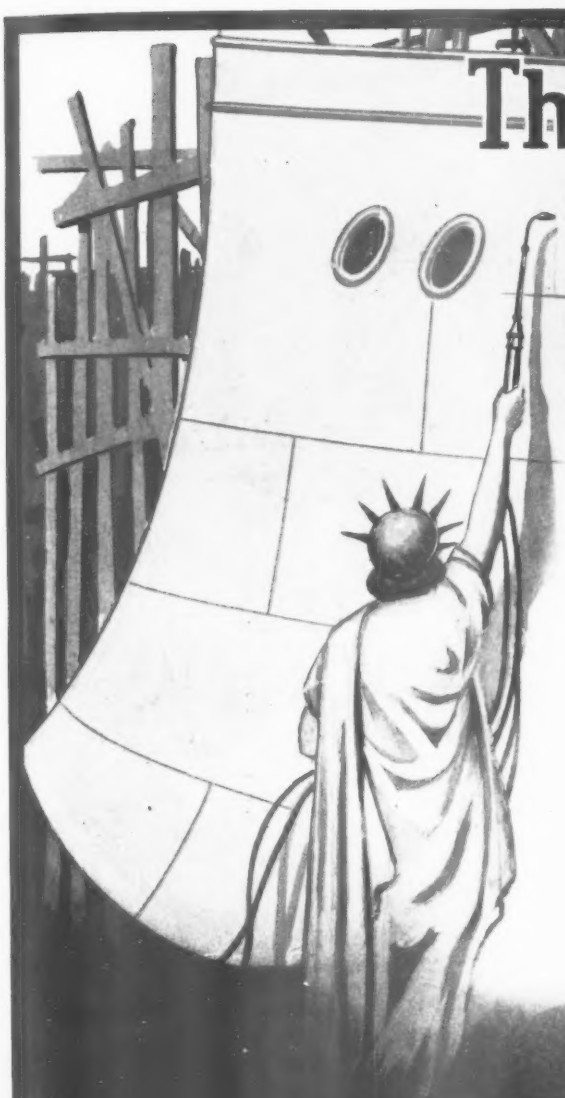
The Welding Engineer

Vol. III. | Chicago 608 S. Dearborn St. | APRIL, 1918 | $2.00 per year in U. S. $2.50 per year abroad | No. 4



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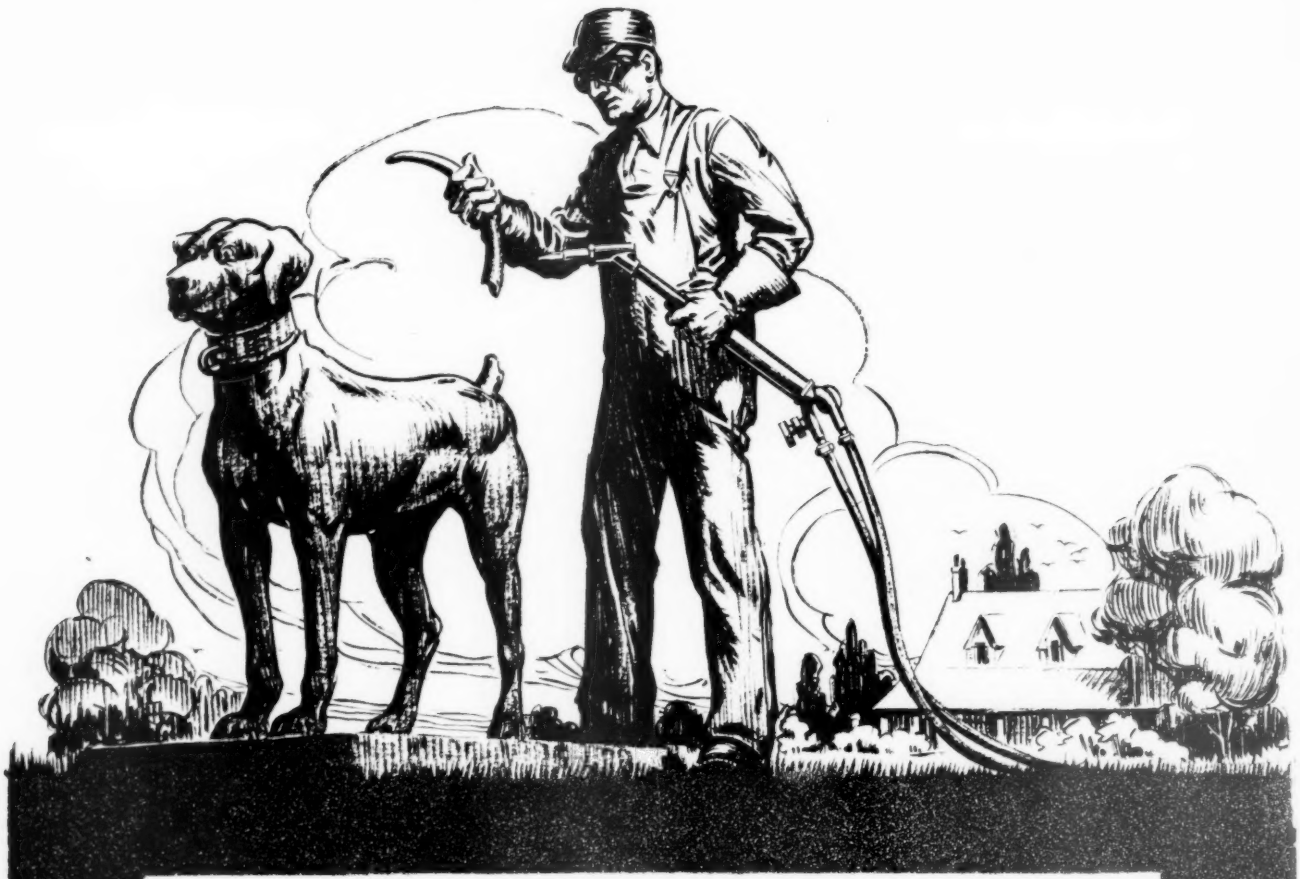

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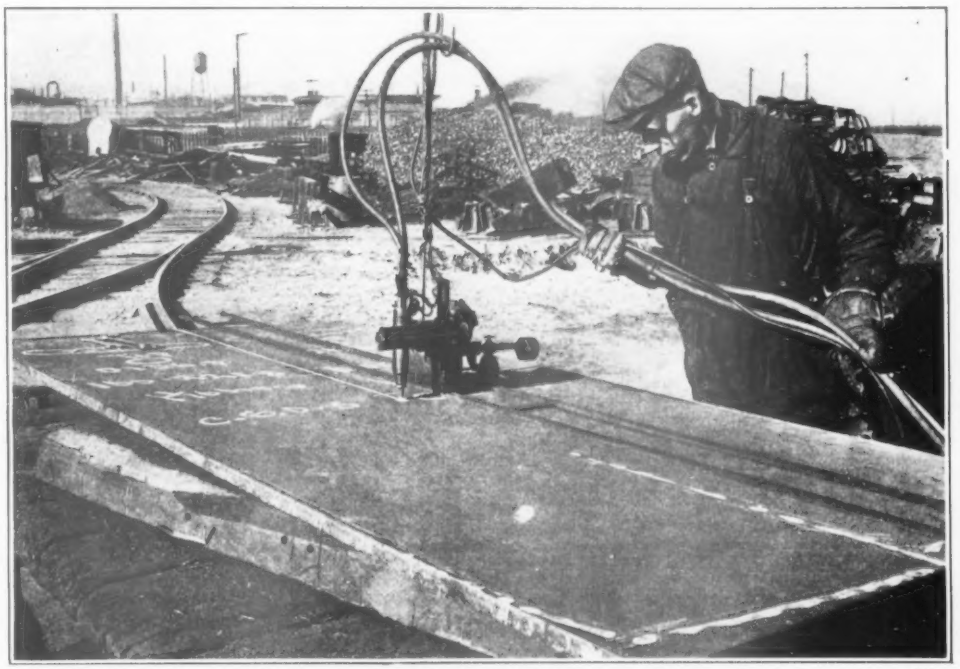

The Radiagraph, an exclusive Davis-Bournonville development for mechanical cutting with the oxy-acetylene or oxy-hydrogen flame, employed for cutting steel plate in the New York Shipbuilding Yard.—Photo by New York Shipbuilding Corpn.

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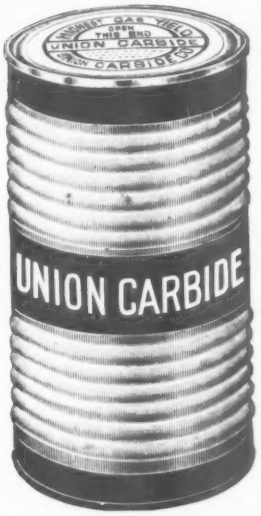

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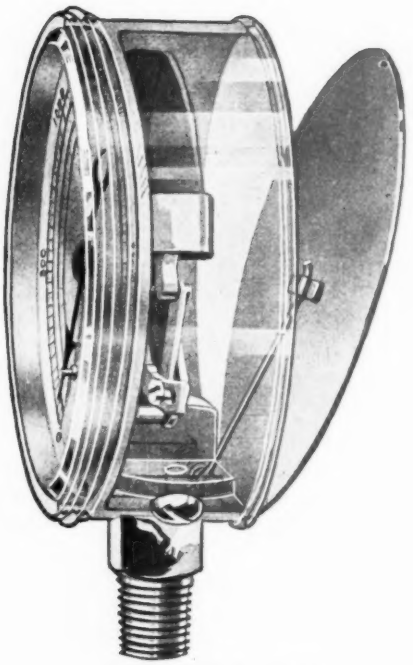

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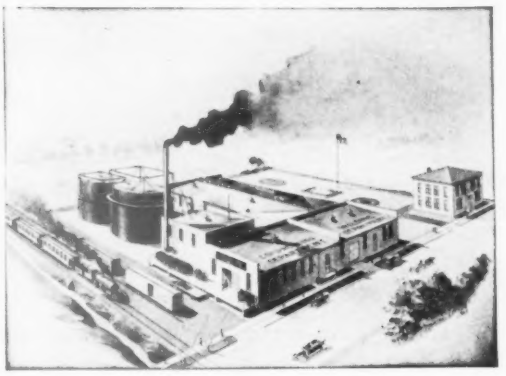

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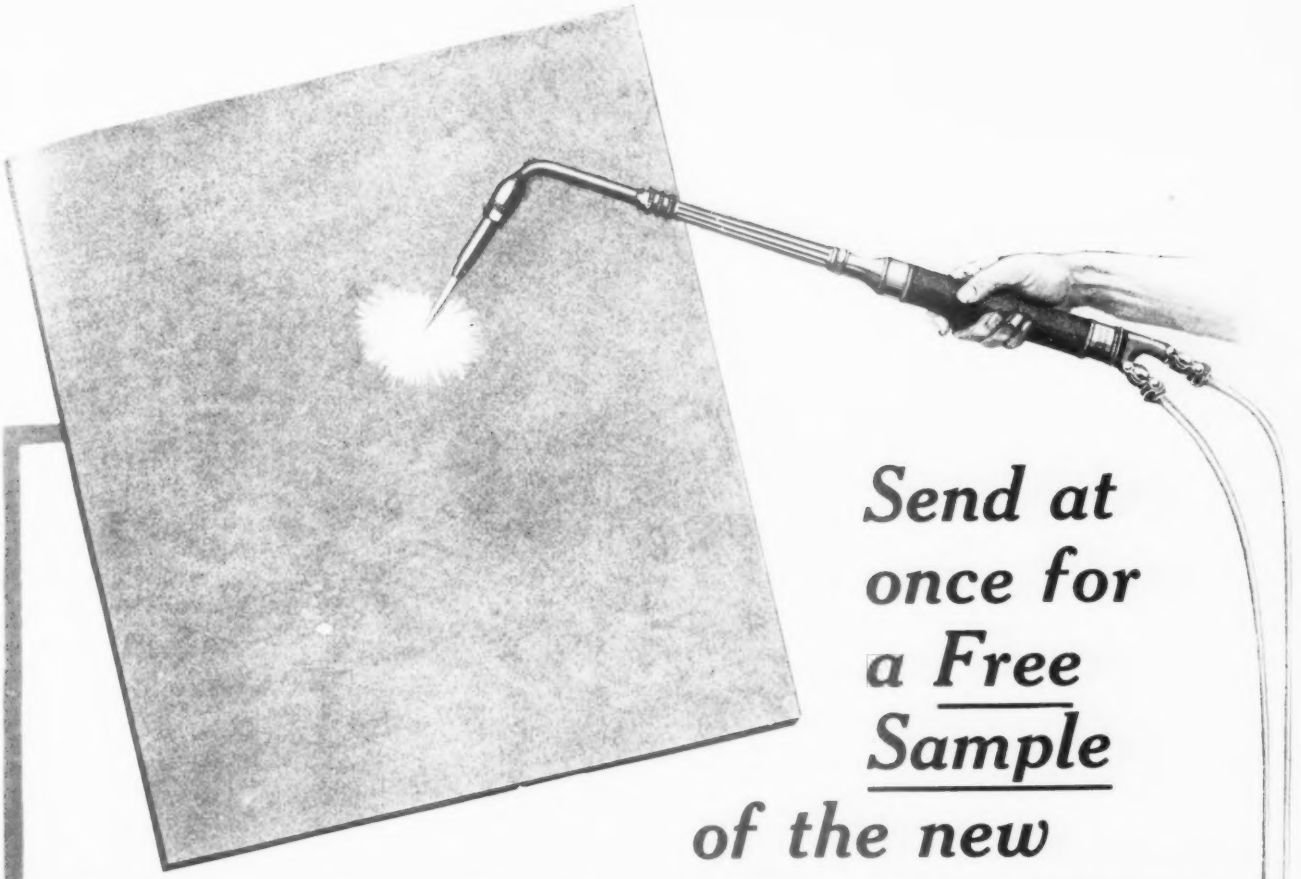

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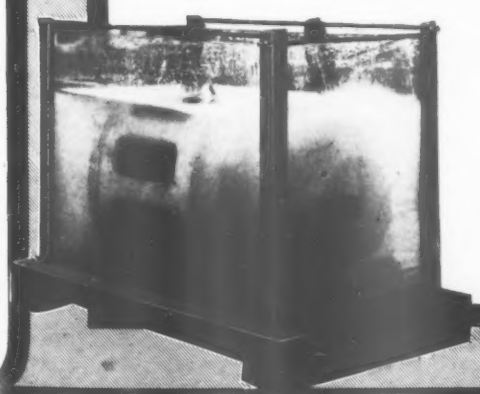

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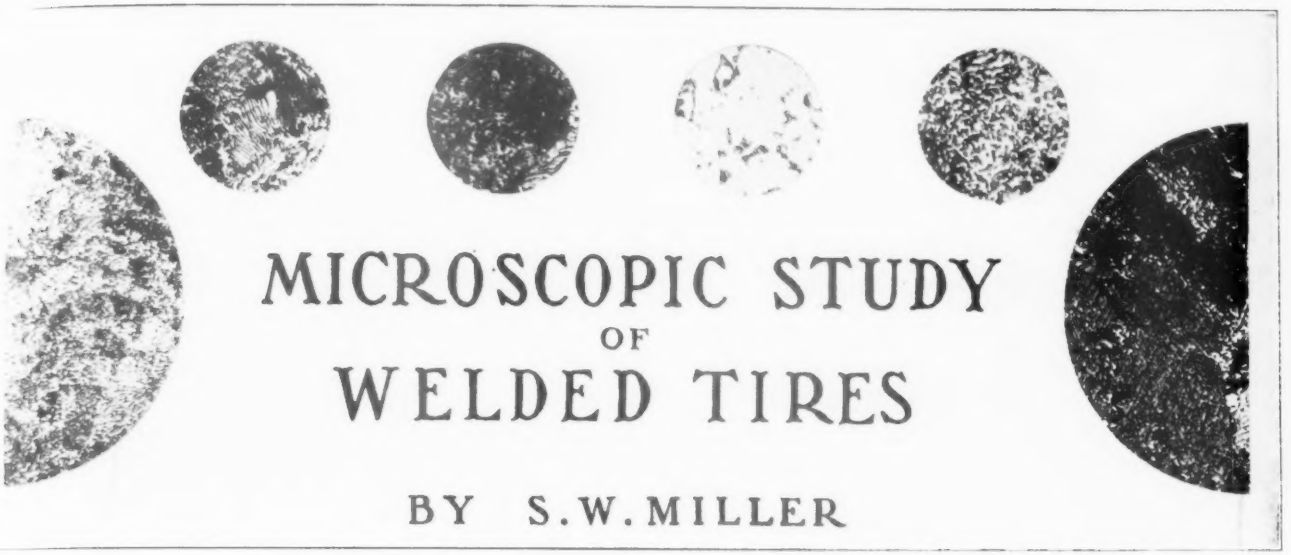

MICROSCOPIC STUDY OF WELDED TIRES

BY S.W. MILLER

Some time ago, the writer's attention was drawn to the fact that it was rather common practice to fill up slid flat spots on steel tires, and to make other repairs of a similar nature, by fusion welding methods, with a view to saving the metal of the tire which would have to be turned off to remove the flat spot. This practice was started because of the apparent resultant saving, not only in tire metal, but in repair cost and time, and if the method was successful it is obvious that this saving would be very great. But there was the

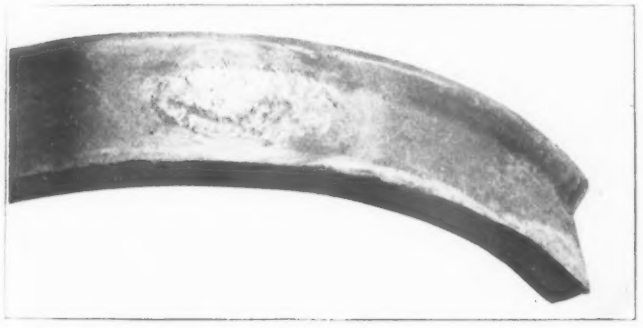

Fig. 1—Section of Tire Showing Welded Flat Spot.

possibility, and a very strong one, that such a method was in reality unsatisfactory, and even dangerous, because of the changes produced in the structure of the metal by the heat, which would change its physical properties.

As the writer knew of no tests showing what had occurred during and after the welding, he decided to make some for his own information, and the results so strongly confirmed his beliefs that they are here presented in the hope that those who may take the trouble to study the matter will see the danger of the practice. Fusion welding processes are capable of wide application, but they are not a panacea and should be used with discretion.

For the purpose of test a scrap tire from a switch engine, shown in Figs. 1 and 2, was selected and the physical and chemical properties were obtained from the manufacturers. A comparison of these properties with the A. S. T. M. specifications for standard switch engine tires is made in the accompanying table, and shows that the tire selected for the test met all the requirements.

The weld was made by the oxy-acetylene process, about ¼ inch of metal being added at the thickest part of the weld, and low carbon steel wire of about .08 per cent carbon content was used as a filler. After allowing the tire to cool to the room temperature it was marked off in sections beginning at the center of the weld, and extending beyond its end, as shown in Figs. 2 and 3. The sections were then cut off in a power hacksaw, polished, etched and photographed.

The etching showed that it was advisable to use three test pieces per section, and these were marked off, as shown on the lines on Fig. 4, which also shows the location, marking and hardness numbers obtained from Brinnell and scleroscope tests.

	Tire to be tested	A. S. T. M. Specifications
Tensile strength	141,200 lb.	125,000 lb.
Elongation in 2 in.	11.1 per cent	8.0 per cent
Reduction of area	29.1 per cent	12.0 per cent
Carbon content	.765 per cent	.70-.85 per cent
Manganese	.707 per cent	Not over .75 per cent
Phosphorus	.047 per cent	Not over .05 per cent
Sulphur	.037 per cent	Not over .05 per cent
Silicon	.239 per cent	.15-.35 per cent

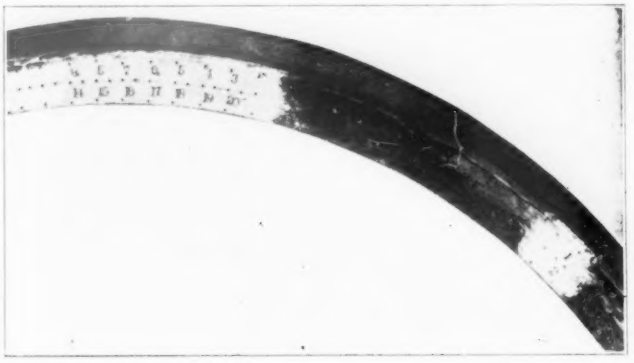

Fig. 2—Tire Marked Off in Sections.

These test pieces were marked to include, as far as could be seen, the same structure as shown by the coloration produced by the etching in Fig. 5, it being desired to obtain a number of test pieces from each type of zone. For example, it was thought that test pieces 4, 7, 10, 13 and 15 (Fig. 3) would probably give nearly the same results, but quite different from test pieces 6, 9, 12 and 14, which were in an entirely different zone, as shown by the etching.

The numbers in Fig. 2 were the ones for the original test pieces, and may be partly seen in Fig. 3, stamped into the

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Mr. Miller is the owner of the Rochester Welding Works.

sections. The white numbers in Fig. 4 are the ones later decided on, and which are used throughout this article.

It appears from Fig. 5 that the changes of structure indicated may be divided into four principal zones. These are zone *A*, the added material; zone *B*, the darkest on which has the finest grain, having been heated above the critical

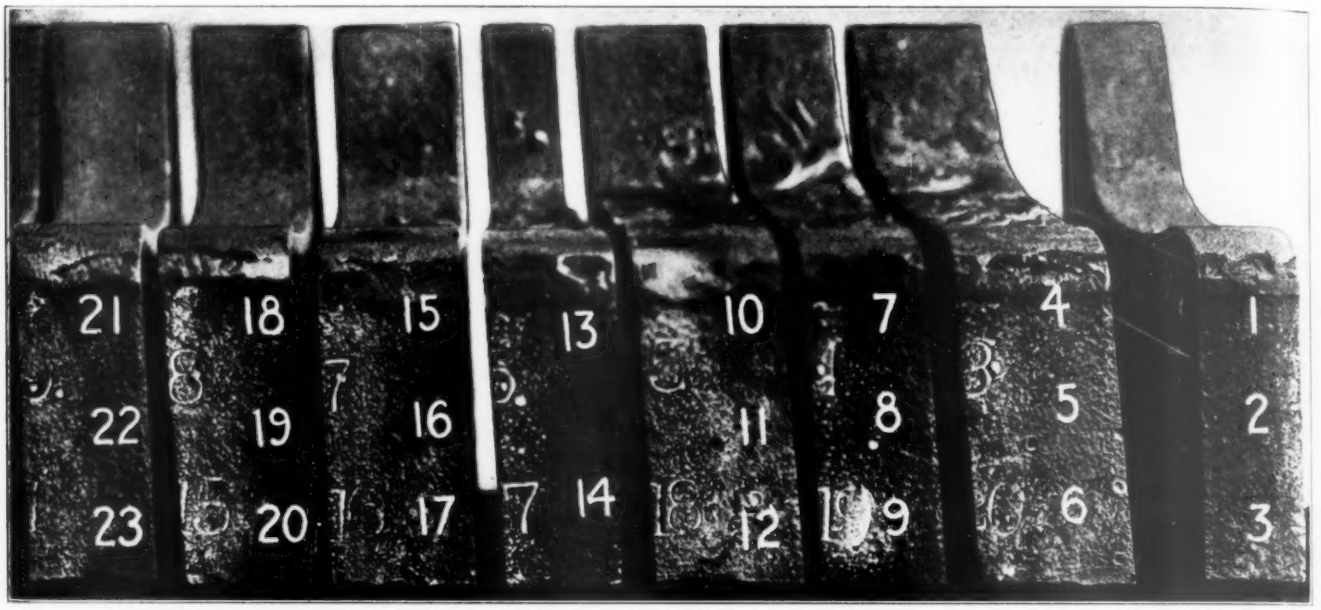


Fig. 3—Sections Cut From the Tire for Test.

range and rapidly cooled by conduction of the heat to the rest of the tire; zone *C*, the lightest one which has been heated within the critical range, and, therefore, softened, and zone *D*, intermediate in color, which has been heated below the critical range and, therefore, is not changed from the original with regard to grain size. This last represents, as nearly as possible, the original condition of the metal before the welding was done. There are also narrow transition zones between *A* and *B*, *B* and *C*, and *C* and *D*, which will be considered later.

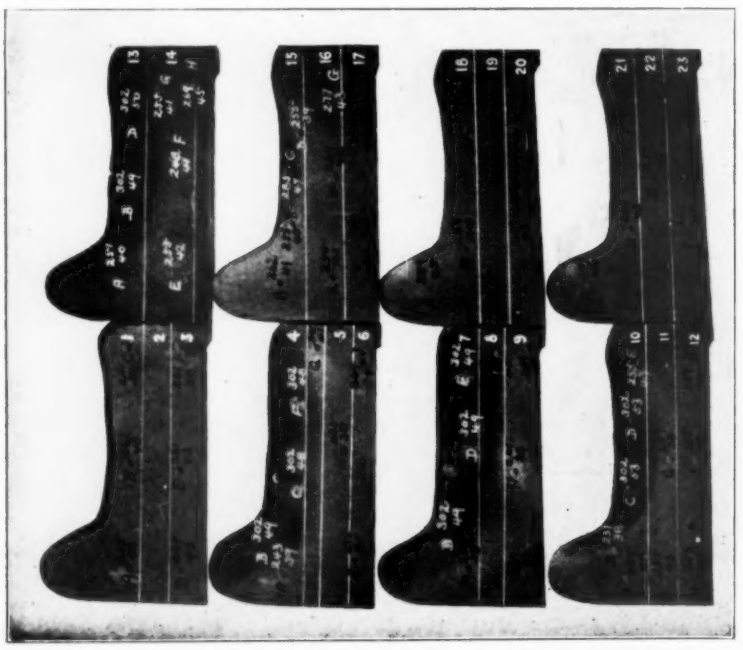


Fig. 4—Sections Polished and Etched, Showing the Hardness Numbers.

It is important to remember that, while the zones appear to be rather sharply defined, the temperature was not uniform in any one zone and gradations within each zone may be observed, except in zone *D*, which has been subjected only to a strong drawing heat, such as occurs some distance back from the point when a cold chisel is tempered after hardening. This heat has altered the physical properties, although it was not high enough to affect the grain size.

The light section of zone *C*, at the left of Fig. 5, is caused by the material in that vicinity having been heated twice. The added material was here first applied lengthwise near the flange, and later the welder returned along the outside of the tire, resulting in the second heating. Such an appearance is always noticeable when the material is so added.

The microscope is necessary to show the changes in the transition zones and the most important of these is the one between *A* and *B*. Here the steel has been decarbonized by the heat, and contains probably about an average of .4 per cent carbon. The width of this zone is from .05 in. to .08 in., and will vary with the temperature and its duration.

The zones between *B* and *C*, and *C* and *D*, are wider, although it is hard to give the dimensions. And while there

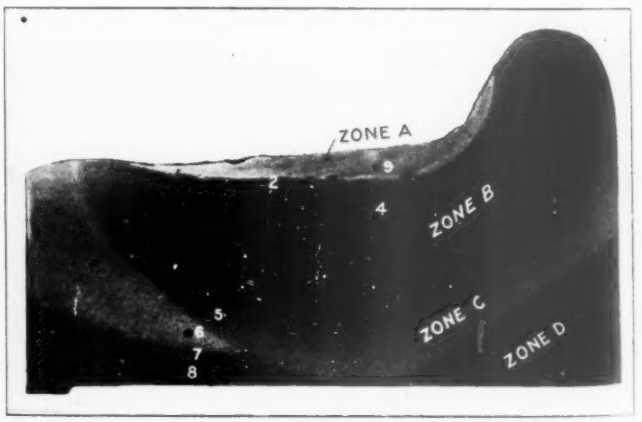


Fig. 5—Etched Section Showing Different Zones and Location of Photomicrographs.

are considerable differences in the structure of the pearlite in any one zone, and while the difference between what might be called a maximum condition in one zone and a minimum condition in another zone may be small, yet the *average* condition in one zone is very different from that in the other zone. A moderate magnification is best for locating such differences.

nsile test pieces were cut from each section, so as to in- e the different structures as nearly as possible and these taken as shown by the white figures in Fig. 4. It was ssary to take them across the tire, and while objection be raised to their not being taken parallel with the roll- yet as the object was to see if any difference existed

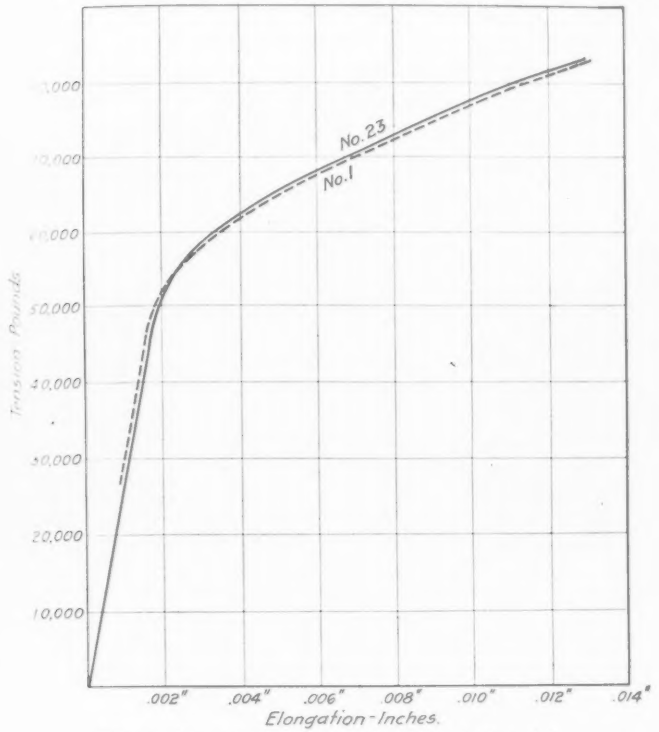


Fig. 6—Stress-Strain Curves for Original Material.

between the physical properties of the different structures, and as they are all taken in the same direction, it is believed that the results are comparative. A Berry strain gage was used to obtain the elongation.

It should be remembered that it was impossible to get the

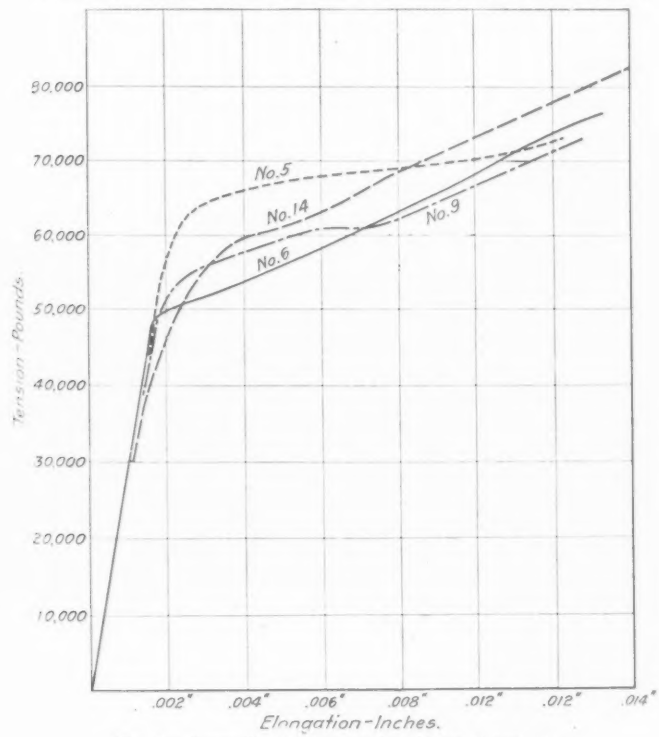


Fig. 7—Stress-Strain Curves for Zones C and D.

test pieces exactly from the places desired, and as the structure throughout any zone is not absolutely uniform, it could not be expected that the results of the physical tests would be exactly, or even very closely, the same for what appear to be the same zones. But, from appearance, test pieces 1 and 23 would be in the same zone—both of unaltered material; 4, 7, 13 and 15 would belong together, and so would 6, 9 and 14. No. 5 would seem to be in a class by itself. (These are the only test pieces from which accurate results were obtained.) It is rather noticeable that the stress-strain diagrams confirm these conclusions, as shown in Figs. 6, 7 and 8.

The curves for test pieces 1 and 23 are of the same type, and lie remarkably close together. Those for 4, 7, 13 and 15 are of a much different type, the elastic limit being noticeably higher, and the material being much more brittle. Those for 6, 9 and 14 show a still different type, of a characteristic general shape, with a much lower tensile strength, but with the elastic limit nearly the same as 1 and 23. No. 5 is somewhat different from the other three types, but approaches 6, 9 and 14 most closely, and so is shown on that diagram.

The average physical properties of the different zones are shown in the table on the following page.

Almost a casual glance at this table will show the great changes that have taken place in the tire due to the heat. In all cases, the tensile strength is lowered. In the darkened

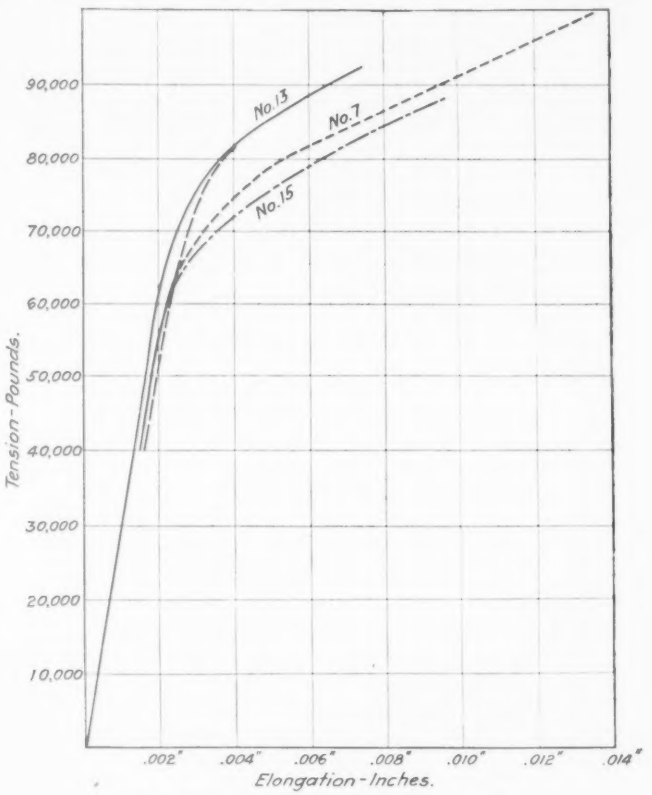


Fig. 8—Stress-Strain Curves for Zone B.

section, zone *B*, which, in places, occupies about half the area, the elastic limit has been raised over 25 per cent, and the elongation and reduction of area decreased over 50 per cent. Certainly if the physical qualities shown by the original material are within reasonable distance of what is correct for tire steel, those in zone *B* should not be tolerated, and the 11 per cent decrease in tensile strength of zones *C* and *D* should at least be looked on with suspicion.

The Brinell and scleroscope figures are given in Figs. 4 and 9. Both of them indicate in a very striking way the differences in the zones, and the scleroscope figures in Fig. 9 show clearly the gradations in the zones before referred to. Both appear to be more nearly related to the elastic limit than to the tensile strength. It will be noted that the metal in the zones as laid out shows to be fairly uniform in any one zone, but that the zones differ quite widely from each other.

Zone *A* is very soft as it is composed of low carbon material, and no readings are given as they would not bear on the subject.

The metal in zone *B* is quite uniform, and is in harder condition than the rest of the tire metal. This is as would be expected, as the metal in this zone received a virtual quench.

The metal in zone *C* is necessarily less uniform than in zone *B*, as the condition of the metal in this zone varies somewhat from one side of the critical range (within which this metal was heated) to the other. This zone has the softest metal of any zone throughout the tire, as would be expected.

The metal in zone *D* shows the effect of the heating of the tire during welding and it has an effect of a more or less severe "draw" (by "draw" is meant a heating to and cooling from a temperature which is below the critical range). This metal may, therefore, be expected to show some lack of uniformity in hardness. If however, the metal at approximately equal distances from the line of the critical range be compared, it will be seen that the hardness is as uniform as might be expected.

The average hardness of the different zones may be given as:

	Brinell	Scleroscope
Zone *B*	300	49
Zone *C*	248	39
Zone *D*	263	42
Original	265	44

diameters and another at 1,200 diameters. It is difficult, some cases, at either of these powers, especially the higher to select a representative field, because of the great variat in even a short distance; but an endeavor was made to co as close to the desired result as possible, a number of pho micrographs being made from each test piece, and the one a pearing closest to the average being selected as representati It was the aim to correlate, if possible, the physical propert and the microstructure, and although this can be done only in a general way, there seems to be a fair degree of correspon ence.

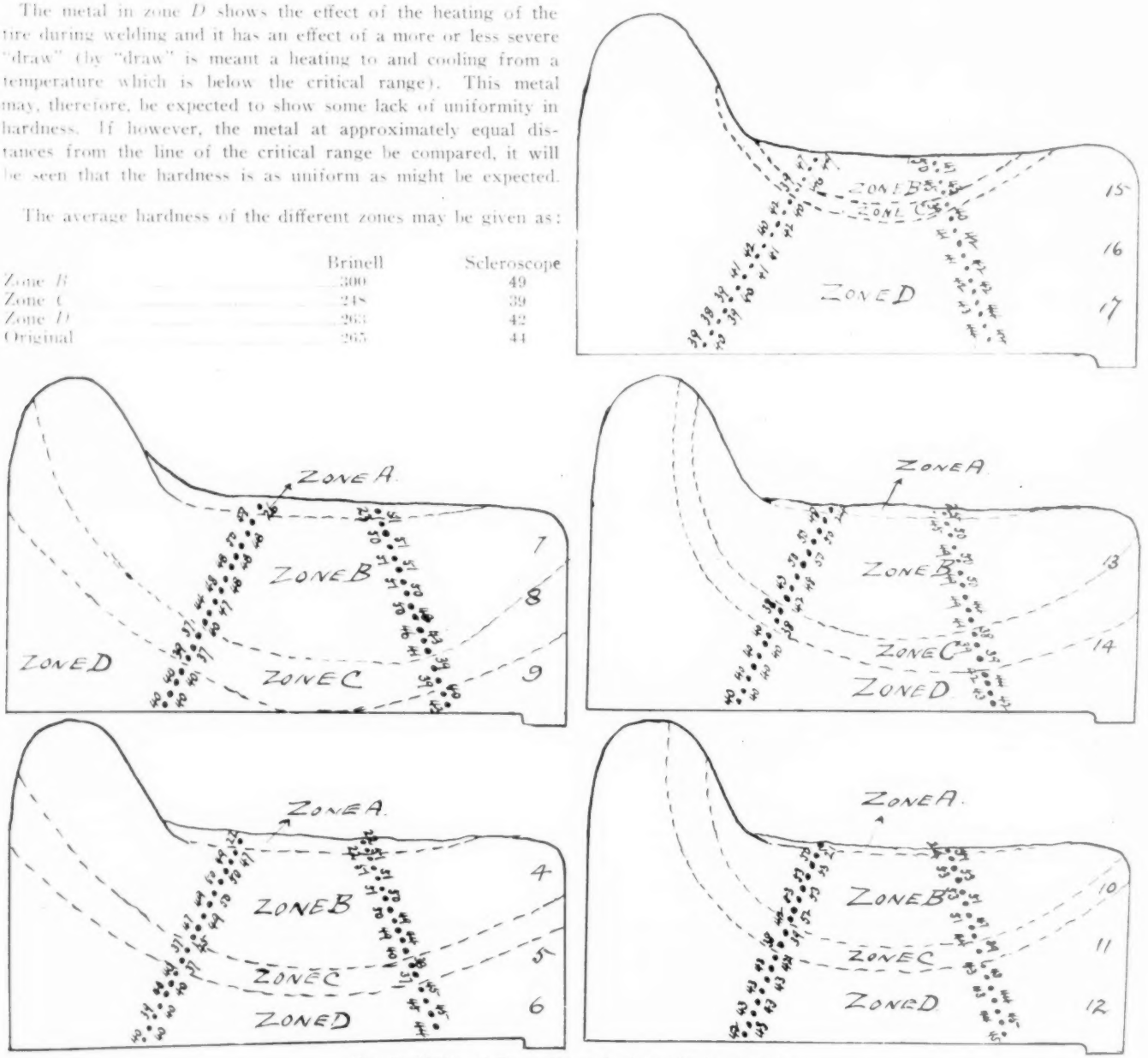


Fig. 9—Limits of Zones Determined by Hardness Tests.

Macro- and Micro-Structure.

Photomicrographs, Figs. 10 to 30, show the structure of the test pieces 3-16 in. from the fracture, and of several spots located and numbered in Fig. 5. One series was taken at 430

The following table, using the nomenclature of Howe and Lev for the different varieties of pearlite,* gives a fair idea of th essential differences in the zones, and should be compared wi Figs. 10 to 30.

Zone	Test pieces	Tensile strength	Elastic limit	Elongation in 2 in.	Reduction of area	Hardness Brinell	Hardness Scleroscope	Modulus of Elasticity	Modulus o Resilience
Original	1, 23	125,250	45,700	3.25 per cent	2.97 per cent	263	43	28,950,000	36.1
B	4, 7, 13, 15	120,900	57,700	1.50 per cent	1.45 per cent	298	49	29,990,000	55.9
C and D	5, 6, 9, 14	110,800	45,500	3.88 per cent	3.07 per cent	245	40	29,950,000	34.4

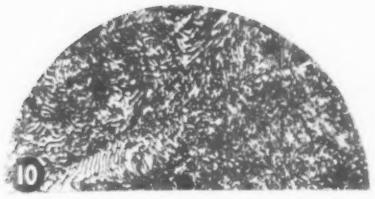


Fig. 10—Test Piece 1—430 Dia.

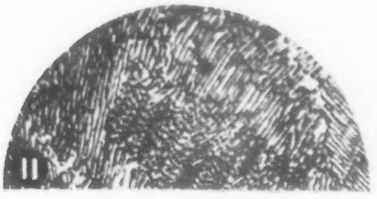


Fig. 11—Test Piece 1—1200 Dia.

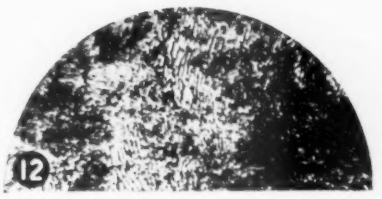


Fig. 12—Test Piece 23—430 Dia.

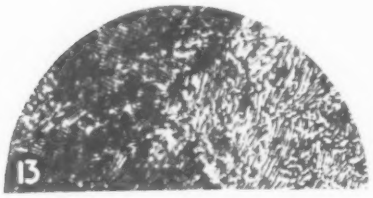


Fig. 13—Test Piece 23—1200 Dia.

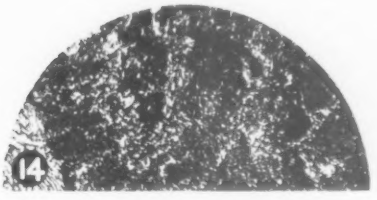


Fig. 14—Test Piece 15—430 Dia.

Fig. 15—Test Piece 15—1200 Dia.

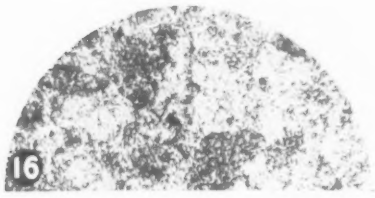


Fig. 16—Test Piece 5—430 Dia.

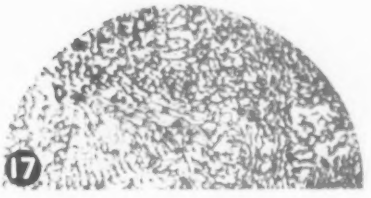


Fig. 17—Test Piece 5—1200 Dia.

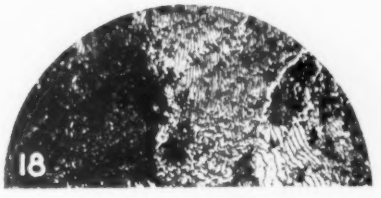


Fig. 18—Test Piece 6—450 Dia.

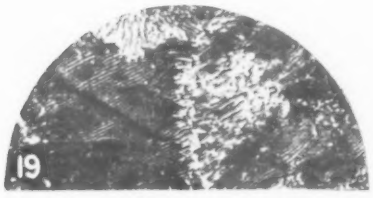


Fig. 19—Test Piece 6—1200 Dia.

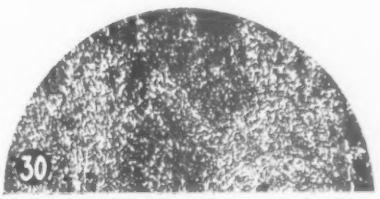


Fig. 20—Test Piece 9—430 Dia.

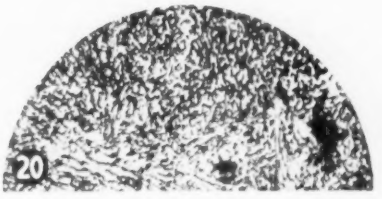


Fig. 21—Test Piece 9—1200 Dia.

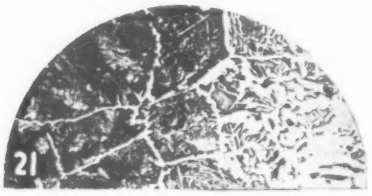


Fig. 22—Spot 2, Fig. 5—50 Dia.

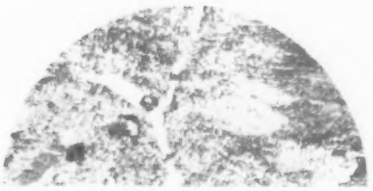


Fig. 23—Spot 4, Fig. 5—430 Dia.

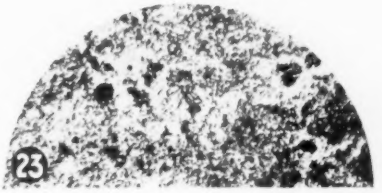


Fig. 24—Spot 5, Fig. 5—430 Dia.

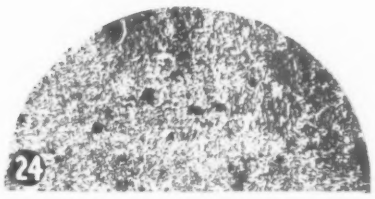


Fig. 25—Spot 6, Fig. 5—430 Dia.

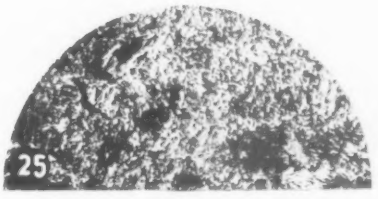


Fig. 26—Spot 7, Fig. 5—430 Dia.

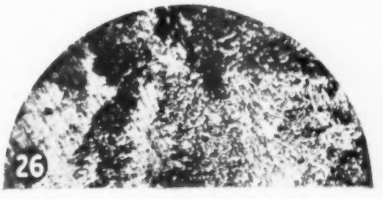


Fig. 27—Spot 8, Fig. 5—430 Dia.

Fig. 28—Spot 10, Fig. 31—50 Dia.

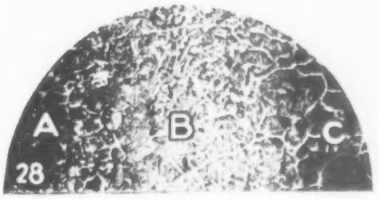


Fig. 29—Spot 11, Fig. 31—50 Dia.

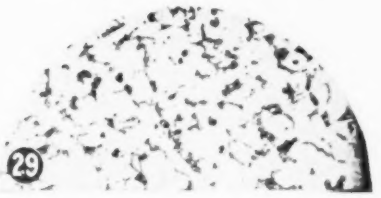


Fig. 30—Spot 12, Fig. 31—200 Dia.

Photomicrographs Showing Changes in Structure of Welded Steel Tires Due to Overheating.

It is interesting to note that the elastic limit in zones *C* and *D* varies but little from that of the original, while the tensile strength is much less. Howe and Levy† discovered that, under certain conditions of heating and cooling, steel of .92 per cent carbon loses much of its tensile strength, while the elastic limit is but little affected. It may be considered that the above

*Journal of the Iron and Steel Institute, 1916, No. II, page 220.
†Journal of the Iron and Steel Institute, 1916, Vol. II, page 233.

Zone.	430 diameters	1,200 diameter	Tensile strength	Elastic limit
B	Sorbite, sublamellar pearlite, ferrite.	Very fine lamellar pearlite, sorbite, ferrite	120,900 lb.	57,700 lb.
C	Sublamellar pearlite, sorbite.	Sublamellar pearlite	110,800 lb.	45,400 lb.
D	Sublamellar pearlite, sorbite.	Fine Lamellar pearlite	110,800lb.	45,400 lb.
Original	Lamellar pearlite, sorbite.	Very fine lamellar pearlite	125,250lb.	45,750 lb.

figures tend to confirm this, although the temperatures and rates of cooling are not accurately known: also, the test pieces were taken crosswise of the tire, so that actual comparisons cannot be made. But it appears that breaking up of the cementite in the pearlite, or, in other words, deviating from normal lamellar pearlite, decreases the tensile strength materially, though it may not affect the elastic limit.

Fig. 24, consists of a mixture of sorbite and sub-lamellar pearlite.

Fig. 28 shows the effect of simply heating the tire to the melting point, and Fig. 30 shows the change at a higher magnification, from which it would appear that the carbon has been reduced, at least in places, to about .4 per cent.

Fig. 22 shows the transition zone between zones *A* and *B*. The decarbonization of the original material is clearly shown by the white ferrite films around the grains in the left half of the photograph. The right half shows the added material.

This is another matter that militates against the use of any welding process in connection with tires. The heat, combined with the oxygen in the air, will certainly remove from the steel some of its carbon, thus making it unsuitable for tires. It might be thought that such a loss could be counter-balanced by using a higher carbon steel for the added material. But this is not possible entirely, and even then not beyond a certain limit, which limit is too low. For example, the simple melting of a piece of tire steel, before adding any material, produces a structure as shown in Fig. 31 at the right; while the use of drill rod containing about .9 per cent carbon results as shown in the same figure at the left.

It also appears that the higher the carbon, the greater the

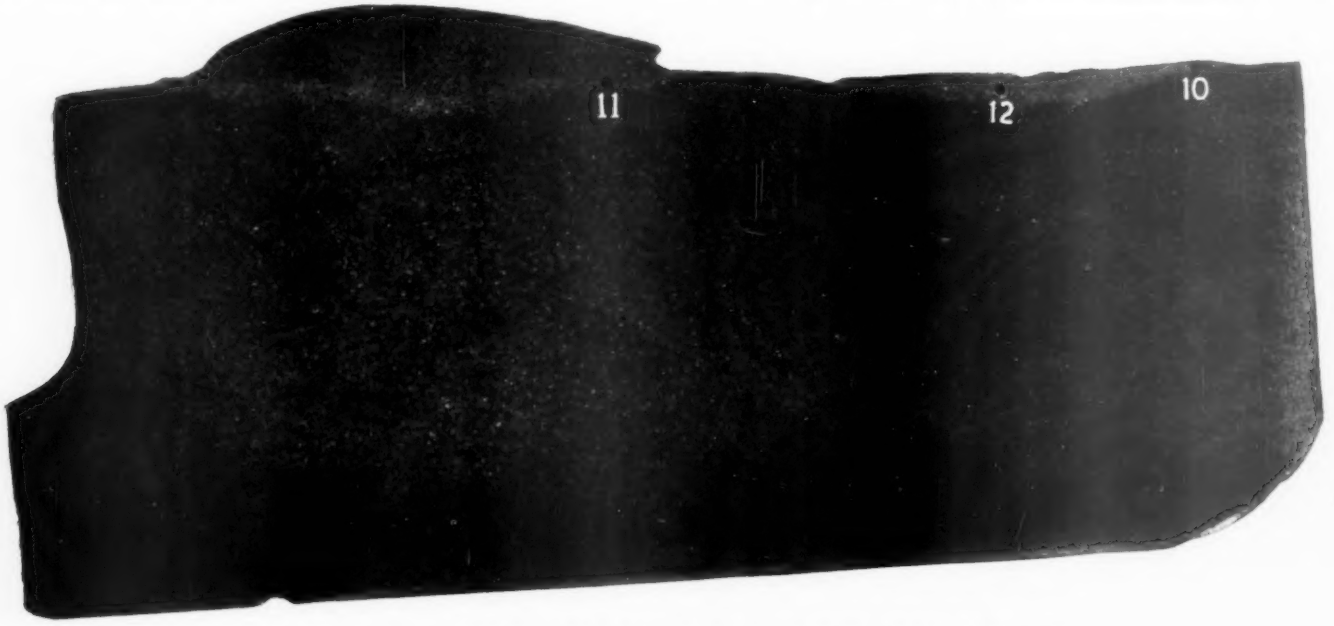


Fig. 31—Structure of Test Piece After Being Heated to the Melting Point—3.5 Diameter.

The change in structure is well shown in Figs. 23, 25 and 27, at a magnification of 430 diameters, and should be compared with Figs. 10 and 12. They are taken from the section shown in Fig. 5, at the points marked 4, 6 and 8. At this magnification, the structure in Fig. 23 is much more sorbitic and also finer grained than that in either Figs. 25 or 27, and it would be expected that such material would be stronger, but more brittle, than materials typified by the other photographs.

It should be noted that, in zone *B*, there are frequent plates of free ferrite, which are rarely seen in zones *C* and *D*. Under higher magnification (1,200 diameters) the sorbitic parts shown in Figs. 23 and 27 usually resolve into lamellar pearlite, those in Fig. 27 being coarser than in Fig. 23. This can also be seen by comparing Figs. 10 and 12 with Figs. 11 and 13.

Zone *C*, Fig. 25, is practically free from lamellar pearlite and sorbite, and is composed almost entirely of what Howe and Levy call sub-lamellar and granular pearlites. It is very similar to Fig. 20. The intermediate zone, between zones *C* and *D*, consists of a mixture of the elements of the two zones, and is shown in Fig. 26, which shows both lamellar and sub-lamellar pearlites.

The transition zone between zones *B* and *C* as shown in

proportionate amount burnt out in a given time; i. e., if a .9 per cent carbon rod is used, the carbon will probably be reduced, as shown roughly by the microscope, to between .5 per cent and .6 per cent, or a reduction of about 40 per cent. There is certainly no such reduction in the case of .08 per cent to .10 per cent carbon steel.

Again, Fig. 29 shows clearly that, in melting the tire steel and adding .9 per cent carbon material, there are four zones: the original metal *A*, with its carbon content unchanged; the original material partly decarbonized by the heat, but not melted *B*; the original metal, melted and further decarbonized *C*, and the added material, partly decarbonized (not shown).

It is evidently not possible to change any of the last three zones to the same condition as the original tire metal, either with regard to grain size, carbon content, character of pearlite or physical characteristics. Therefore, it appears to the writer futile to experiment with different added materials, even if no damage of other kinds were done to the tire.

It is not believed necessary to elaborate other objections, but one point should be spoken of. While the writer is not familiar with all the torches on the market, yet none of those he knows of has sufficient capacity to make a sound weld

[illegible] in. thick without preheating the tire; and, of course, [illegible] treatment would have as bad, if not worse results, as the [illegible].

[illegible] following objections to fusion welding, as applied to [illegible] are the principal ones:

[illegible]: The physical properties of the tire are seriously al[illegible] by the heat applied.

[illegible]ond: It is impossible that the added metal be of the [illegible] quality as the original.

[illegible] course, the former is the more important.

[illegible] it may be urged that the fusion welding of tires is a [illegible]able emergency measure under present war conditions. While the writer believes it a dangerous practice, it might be permissible in certain cases where danger would be a minimum, [illegible] in the case of switching engines in light service. But in times of stress in railroad service, temporary repairs are less useful than during periods of light traffic, because any accident causes worse congestion. And there is much more chance of loss of life when large numbers of people are being transported, as at present, than under normal conditions, from *any* kind of accident. So it appears that any practice carrying with it an element of danger, should not be permitted, especially during periods of stress and hard service.

Of course, it would be entirely possible to restore the condition of the heat changed parts of the tire to their normal state by proper heat treatment. There can be no objection to this, provided it is properly done. Practically no railroad shop has facilities for this work, although they could be readily provided. On the other hand, it is a question if the number of slid flat tires is sufficient to justify the installing of the apparatus necessary, and, under proper conditions of brake equipment, etc., there should be little of this trouble.

So that, everything considered, it is seriously a question if a practice attended with such possibilities of danger should be followed unless the heat treatment referred to can be accurately carried out.

HANDY ARC WELDING RESISTANCE

By E. L. Work*

Here is an arc welding resistance which we have found to be most useful. We have been using it for some time and with it a welder has no use for an ammeter, since he knows the current that will flow with different combinations of switches and he is always operating with a closed circuit.

Below is given a sketch of the wiring diagram of the resistance circuit for electric welding.

The accompanying sketch is a wiring diagram of an electric welder circuit, which we have found to be very useful and convenient to operate.

Nos. 1, 2, 3, 4 and 5 are single pole, single-throw knife switches.

No. 7 is a bank of resistance composed of 48 parts or girds.

Switch No. 1 short circuits 1 part or 1/48th of total resistance.

Switch No. 2 short circuits 2 parts or 2/48ths of total resistance.

Switch No. 3 short circuits 4 parts or 4/48ths of total resistance.

Switch No. 4 short circuits 8 parts or 8/48ths of total resistance.

Switch No. 5 short circuits 16 parts or 16/48ths of total resistance.

Switch No. 6 is a double pole, double throw, and when in position A all resistance is in series and when in position B the resistance divided in the center and each half placed in parallel.

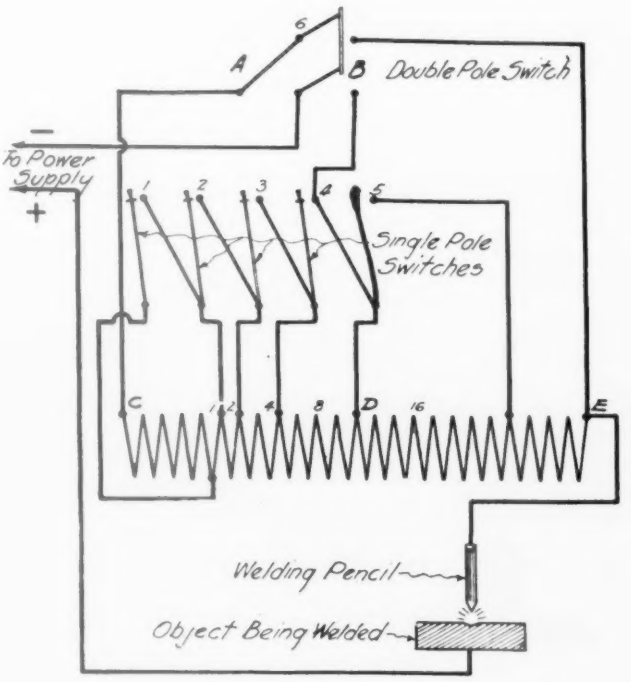
*Secretary-treasurer, Ideal Face Shield Co., Columbus, Ohio.

For pencil welding place switch No. 6 in position A and have switches Nos. 1, 2, 3, 4 and 5 open, which will give you the smallest amount of current, for all resistance is in series. By opening and closing switches Nos. 1, 2, 3, 4 and 5 you can gradually increase your current and get 32 different regulations from lowest to highest.

By closing switch No. 1 you cut out 1/48th of resistance. By opening No. 1 and closing No. 2 you cut out 2/48ths of resistance.

The following combinations will change the resistance as shown at the right

Switches Closed	Portion of Resistance Cut Out.
1 and 2	3/48
3	4/48
1 and 3	5/48
2 and 3	6/48
1, 2 and 3	7/48
4	8/48



1 and 4	9/48
2 and 4	10/48
1, 2 and 4	11/48
3 and 4	12/48
1, 3 and 4	14/48
2, 3 and 4	14/48
1, 2, 3 and 4	15/48
5	16/48

The largest mount of current is obtained by closing switches Nos. 1, 2, 3, 4 and 5, which cuts out 31/48ths of the total resistance, which will give you the largest current with resistance in series. For carbon welding place switch in position B and have switches Nos. 1, 2, 3, 4 and 5 open.

By operating switches Nos. 1, 2, 3, 4 and 5 as described above, you get 32 more, making 64 different currents from lowest to highest.

D. Richardson, known to the American trade as Editor of The Acetylene and Welding Journal, of London, England, has been promoted to a captaincy in the Royal Flying Corps.

Captain James Caldwell, R. E., of the British Army, is in the United States, consulting with American Electric Welding Engineers. Capt. Caldwell is an authority on this subject and it is understood that his services are being given the Emergency Fleet Corp.

TRAINING SOLDIER WELDERS*
LECTURE NUMBER ONE
Subject—Operation

1. (a) Under what pressure is Oxygen gas received in the cylinders used commercially?
   (b) Does this pressure vary to any great extent with changes in temperature?
2. (a) Under what pressure is Acetylene gas received in the cylinders used commercially?
   (b) Does this pressure vary to any great extent with changes in temperature?
3. (a) In setting up appartus for the first time, or in attaching regulators to new cylinders, what precaution should be observed regarding cross-bar on regulators before the gas is turned on?

   (b) Where should the operator stand when turning on the gas?
4. (a) How much pressure should be placed on the Oxygen hose, when the torch-valves are closed, before starting to operate with a medium sized tip?
   (b) How much pressure should be placed on the Acetylene hose, when the torch-valves are closed, before starting to operate with a medium sized tip?
5. (a) After both the Oxygen and Acetylene gases are in the line hoses as far as the torch, which valve on the torch is opened first in order to light?
   (b) What would happen if the other torch-valve were opened first?
   (c) What would likely occur if both valves were [illegible] before torch was lighted?
6. (a) How is it possible, when lighting torch, to determine whether enough pressure is on the Acetylene line without looking at gauge?
   (b) How is it possible, in the case of Oxygen pressure
7. (a) What is meant by a neutral flame?
   (b) How hot is a neutral Oxy-Acetylene flame?
   (c) Is the temperature of a neutral flame the same whether large or small tip is used?
8. (a) If too much Acetylene gas is used, how will the flame be effected?
   (b) What action will this have on the weld?
9. (a) If too much oxygen gas is used, how will the flame be effected?
   (b) What action will this have on the weld?
10. (a) Explain briefly how apparatus is shut-off, when not to be used for several hours or more.
   (b) Why should particular care be taken to see that Acetylene cylinders are tightly closed when empty?
   (c) What action does oxygen have on oils and grease?

*Twenty lectures, based on practical instruction given soldier welding students at the Army School at Peoria. An article written by Lieut. Campbell, of this school, was published last month.

LECTURE NUMBER TWO
Subject—Apparatus

1. Name the different classes into which Oxy-Acetylene welding apparatus may be divided and explain the principles upon which this classification depends.
2. Illustrate by line sketches the various locations of the mixing chambers for the Oxygen and Acetylene gases in welding torches.

(Continued on Page 28)

LIEUTENANT ROBERT E. KINKEAD.

...sing young mem...l er of the firm of Uncle Sam, J. Bull Unlimited, is Lieutenant (J. G.) Robert Emerson ...ad, now on sea duty on the battleship U. S. S. South ... Our friend Bob, the citizen, was known as a mild ...ered young fellow, but when he comes back we suppose ...ll walk with a roll to starboard and be constantly cuss... top gallants, or some other part of the ship. Lieuten... Kinkead was born March 20th, 1890, at Greenville (Darke ...ty) Ohio. He was graduated from the Ohio State Uni...

Lieutenant Robert E. Kinkead.

...versity in 1913 (M. E. and E. E.). For the past three years ...e has been connected with the welding department of the Lincoln Electric Co., Cleveland, O. He is regarded as being ...ne of the foremost arc welding engineers of this country ...nd, while no facts may be published, it is certain that his ...raining and experience is being made use of by the Navy.

Before being assigned to duty he completed a course of ...raining at Annapolis, similar to that given at the Army Re... Officers' Training Camps.

WELDING SHIPS ELECTRICALLY

More Plans to Beat the Hun by Speeding Up Production.

For the first time in the history of American shipbuilding ...e electric welding process is to be applied in hull construc... with the ultimate view of using the electric torch exclus... ...ly instead of the slower method of riveting. Word of this ...rtual revolution of marine engineering which is being ...ched with the keenest attention by shipyard officials on ... the Atlantic and Pacific coasts, was brought to this ... yesterday by Walter J. Jones, research and experimental engineer of the Chester Shipbuilding Company and member of the Committee on Welding of the United States Shipping Board.

According to Mr. Jones, at one time assistant to the late Dr. F. A. C. Perrine, a famous research engineer connected with the Stanley Electric Company, Pittsfield, Mass., material is being assembled at the Submarine Boat Corporation's yards in Newark for a 9,000-ton cargo boat. A fifty-foot section of this vessel, the keel of which will be laid shortly, will be put together by a process of spot welding, and finished and made water tight by various forms of arc welding.

Not as an Experiment

This work, Mr. Jones said, is not to be done as an experiment, but as a demonstration of the value of the method, which already has been proved abroad, especially in the British navy, where a considerable part of hull work by torch has been done in the case of both cruisers and battleships. "Furthermore," he added, "there is every reason to believe the Emergency Fleet Corporation will shortly authorize the complete construction by welding of a 5,000-ton, or perhaps even larger, vessel of the prevailing design."

Though the welding process has been used extensively for years in repair work, its application for the building of ships is a recent development growing out of the submarine war and the urgent need for new ships to replace the lost tonnage. Realizing the possibilities for an increased output by means of electric welding the special committee, composed of more than a score of the best known engineers and experts in the country, was appointed by the Government to devote its time to a study of the method and the most practical application for national purposes.

For some time a strenuous campaign originated by James G. Dudley, another research and experimental engineer of the Chester corporation, has been carried out to gain public recognition for the process, which it is urged should be adopted universally the better to offset by new construction the number of ships sunk weekly by the Central Powers.

Mr. Jones' return to his offices here followed a meeting in New York of the Committee on Welding, in the course of which details of the Newark vessel were discussed. Suitable foundations for the ship section to be welded are being prepared at the yard to allow of severe tests by pressure, as well as every agency to develop the merits of the system, and, according to Mr. Jones, work is being rushed on the completion of some of the special apparatus required for the work. The latter is under the direction of Arthur J. Mason, of the Emergency Fleet Corporation, who also will look after the special system of "clamping" the plates to hold them in position until they have been welded into the permanent shape of the hull.

Big Saving in Time

The great saving in time over the method of riveting which, as already pointed out by Mr. Dudley, would permit the construction of 400 welded ships in the period it now requires to rivet 300, was further emphasized by Mr. Jones. Based on practical results, he said, it has been found that one welder can accomplish the work of one "rivet gang," which generally comprises four men, a riveter, heater, a "holder-on" and a passer.

The ability of welded objects to withstand great strain and intense vibration has been questioned in some quarters, Mr. Jones said, but long experience has shown that if anything the welded parts are stronger than any other form of joining, and the solid metal will give before the welded seams could be torn apart. In this connection he cited a fifty-ton steel gondola car, manufactured by the welding process, which today after seven years' hard usage, during which it figured in a side-swiping wreck, is as good as on the day it was first placed in service. Numbers of locomotives and cars in operation and built by the same method are equally as

good as they were upon construction, and in their cases the vibration occasioned by running over the track is much greater, according to Mr. Jones, than that caused to a ship under what is technically known as "cushion vibration" and the longitudinal strain caused by laboring in a heavy sea.

All claims for the adaptability of welding in ship construction are guaranteed by scores of the best known experts throughout the country, Mr. Jones pointed out, and especially so by the members of the Committee on Welding, headed by Professor Comfort C. Adams, of the Massachusetts Institute of Technology. Other prominent members include David B. Rushmore, consulting engineer of the General Electric Co.; E. A. Stevens, field officer of the Emergency Fleet Corporation; Constructor Knox, U. S. N.; H. A. Hornor, a leading marine engineer of this city, formerly connected with the New York Shipbuilding Co.; E. C. MacNary, industrial training and welding expert of the Emergency Fleet Corporation, and some eighteen or twenty other and equally well known shipbuilding and engineering experts.

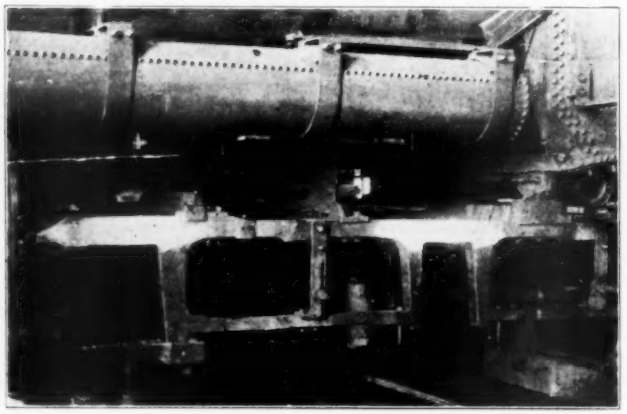
The recent statement by Mr. Dudley that anybody could become a trained welder in from two to six weeks has resulted in the receipt at his office of applications from men willing and eager to enter this new field. Yesterday, however, he received the first application from a woman, Mrs. E. H. Pease, of 616 South Broad street, who expressed the patriotic desire to aid in the shipbuilding program by offering her services as an electric welder.

"If you will inform me where this new art of electric welding is being taught, I wish to enroll at once," Mrs. Pease concluded her letter. The Chester Shipbuilding Co. is the most extensive user of the welding method in this district, and, according to Mr. Jones, there is a possibility that a school of welding will be established here by the management.

A DOUBLE WELD.

Editor:

This photograph shows a double weld made on new front section applied to our new standard freight locomotives.



Double Weld on Engine Frame.

This was done for less than half the cost of another system and a better and neater job. Since photo was made we have done several of these jobs.

H. C. Spicer.
A. C. L. R. R.

The Welders Engineering Company, Tulsa, Okla., is installing one of the most modern welding plants in Oklahoma, with A. M. McCutcheon manager, assisted by a staff of high grade welders.

C. A. McCune, engineer for the Commercial Acetylene Supply Co., has resigned, to enter the service of the American Rolling Mill Co., New York. He will sell welding rods and wires.

CAPTAIN PAUL PLEISS

Captain Paul Pleiss, Hydrogen Division, Aviation Section, Signal Corps, United States Army, was born in Milwaukee, Wis. In 1909 he entered the service of the American Hydric Co., and the following year he started a welding shop of his own in Milwaukee. He operated this shop successfully and obtained a great deal of practical knowledge of the welding business, from a welder's standpoint, during the next year. In 1911 he entered the service of the Davis-Boumonville Co., as a salesman in the Chicago office. Later he joined Mr. J. B. Burdett, and his associates, in the formation of the Burdett Mfg. Co., as secretary and Eastern sales manager. He has been a director of the company since its incorporation and was, perhaps, the moving spirit in its activities.

At the beginning of the war Captain Pleiss offered his services to his country and was immediately commissioned a Lieutenant in the Signal Corps.

His training and experience won him instant recognition and his promotion to a captaincy followed quickly. He is now in charge of a Balloon Division and has been in France since the first of the year.

Captain Paul Pleiss.

Captain Pleiss is known in the trade from coast to coast. It is the earnest hope of his friends that he may have more opportunities to demonstrate his worth.

ENLIST YOUR DOLLARS FOR THE PERIOD OF THE WAR

By W. G. McAdoo, Secretary of the Treasury

Again the American people have the privilege of lending their money, their savings, to their Government for the purpose of making the lives and liberties of every American safe, and of securing the lives and liberties of the gallant nations which fight with us.

These bonds bear 4¼ per cent interest, they are exempt from all Federal, State and local taxation, except the Federal superincome taxes and inheritance taxes. They are due ten years

after their date. They are the safest investment in the world and they bear a rate of interest adequately and generously remunerative. The money derived from these bonds will be used to supply our soldiers and sailors with the food, clothing, guns, ammunition and other essentials which they must have if they are to win this war; to pay the wages of labor of those who are engaged in manufacturing these essential supplies; to pay for the raw materials and the farm products and the countless other things that enter into the war program of a great nation. We must not, we cannot, consider the purchase of Government bonds as a purely commercial or business transaction. War is not business, although the nation's business now is war. War is the death struggle for the principles and ideals for which a nation fights. Business must be adjusted to war and every ordinary rule of business must be modified, altered or discarded, if necessary, to meet the supreme need of the nation in such a time. National necessity is the supreme law of war, and the first duty of every citizen is to subordinate himself and every interest to that supreme necessity.

To lend one's money on safe security is at best a small contribution compared with the sacrifice the dying soldier makes, the sacrifice the widow makes, the sacrifice the mother and father of a dead hero make. Patriotism must at all times be the mainspring of action, not only in the purchase of bonds, but in every other thing the good citizen does in the support of his Government in time of war.

Let us not, therefore, consider the purchase of Government bonds merely as a commercial or business transaction, merely as an investment, however safe it may be. Let us consider it a privilege as well as a duty to perform this part of the essential service required of us so long as the war lasts.

It is not enough to merely subscribe for a bond. The chief value of the subscription lies in the fact that the purchaser keeps his bond; that he denies himself something in order to keep it; that he saves something in order to buy it. When you lend your money to the Government you must not sell your bond immediately on the market because you do not help in that way. Every unnecessary sale of a Government bond tends to depress the market price, and the more the market price of Government bonds is depressed, the more hurtful it is to the Government's credit and to the genuine interest of the people of the United States.

If the price goes below par, there is an immediate demand on the part of the thoughtless people for an increase in the rate of interest, and every time the rate of interest is increased, a new burden of taxation is imposed on the mass of the American people. I know that we are as people sensible enough and strong enough and patriotic enough to continue to supply the Government with all the money it needs at a reasonable rate of interest. Let us make a fight now to stabilize the rate and let us prove to the world that America's patriotism is not determined by the rate of interest per annum or by any other mercenary consideration.

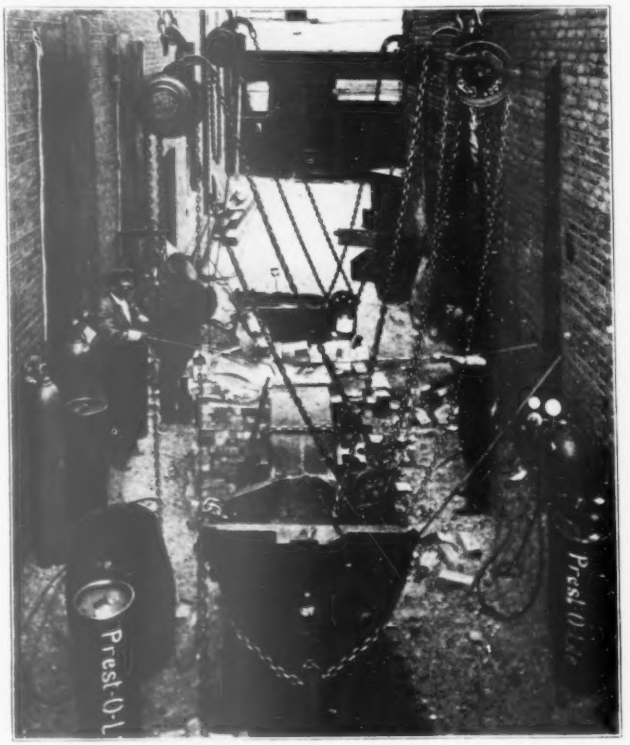
We must also learn that the first duty is to save. We are entering the second and I hope the final stage of the war, the victorious stage for America. It is the savings of the people that constitute the real strength of the nation's power to produce and to supply the things indispensably required for the war. Every ounce of wool saved, every pound of food saved, every stroke of labor saved, is power exerted upon the battle-front. We, therefore, add measurably to the strength of the nation by practicing economy and preventing waste.

14 TON CASTING

Editor:

Seeing your article in *The Welding Engineer* under heading of "Advertising the Job Shop," we wish to submit to you, for your approval, a picture of a job which we completed last month.

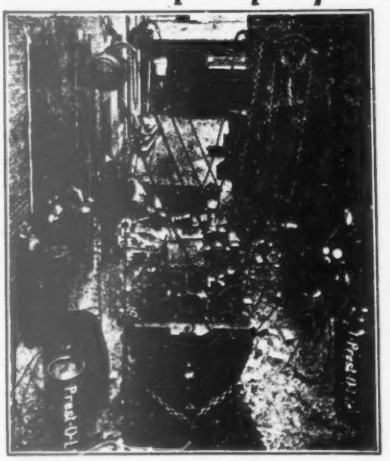
You will note sheet asbestos, then sheet metal, over windows to keep the heat from cracking same, also snow on the buildings in the rear, and one welder with sleeves rolled up.



This job took three nights and the best part of four days. Both of our men never left the job, from beginning to end. When our crew came to turn the Ram over, our welders slept in the boiler room, until we got the Ram to the right temperature for them to begin welding again. We stacked or built in over eight hundred pounds of virgin metal.

(*Continued on Page* 27)

We Make Your Scrap Heap Pay Dividends



Saving One Company Twenty-Eight Hundred Dollars and Three Months' Delay on Delivery.

The next time you have a broken machine part or a broken casting—instead of investing money in a new part and wasting going time waiting for its arrival—remember that the broken part can probably be welded by the oxy-acetylene process.

EXPERT WELDING OF STEEL, CAST IRON, COPPER, BRASS AND ALUMINUM, BRAZING, LEAD BURNING AND CARBON BURNING. STRAIGHTENING OF AXLES AND FRAMES. WE GO ANYWHERE TO DO THE WORK THAT CANNOT BE BROUGHT TO US.

LARGE CASTINGS AND BOILER WORK OUR SPECIALTY. WE HAVE A U. S. GOVERNMENT PERMIT TO DO SUCH WORK IN THIS DISTRICT

Detroit Prest-O-Welding & Cutting Co.

WALTER D. GRANT — 568 Clay Ave. Tel. North 289 — J. L. VAN ARSDALE

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VOLUME 3 APRIL, 1918 NUMBER 4.

Is Uncle Sam's Word Good?

BILL SIMCOE borrows $1,000 and gives his note and a mortgage on his place. The security is all right, of course, or he wouldn't have been able to pry loose the $1,000. But behind that stands the fact that the lender had faith in Bill Simcoe's word. "His word is as good as his bond," that is what the neighbors say of him. Faith in Bill Simcoe has as much to do with the transaction as anything else.

The United States of America includes Bill Simcoe, and you, and me and 111,000,000 others equally as good as we are. Whereas Bill Simcoe's ability to repay what he borrows rests entirely on his farm and his strong right arm, the ability of the United States to pay back what it borrows rests on the earning power of 111,000,000 husky men and women who wear "Stars and Stripes" in their button holes. Uncle Sam has the power to tax every one of the people to make good any promise of payment he makes. And the people have 3,000,000 square miles of territory to earn tax money for them, when Uncle Sam calls.

Mr. William Hohenzollern knows this and he has started out to conquer the United States, so that he will be able to levy fifty billion dollars tribute from the American people. If he can win the war he will be able to make us pay anything he demands.

Now Uncle Sam comes to the people and says: "I must borrow some money to beat off the Kaiser. I will pay you back in a few years and in the meantime I will give you 4½ per cent interest and certain tax exemptions. You won't lose a cent, but on the contrary you will have the safest and best investment in the world, holding LIBERTY BONDS."

Do you believe Uncle Sam? Is his word good? Well, you are part of Uncle Sam yourself. If you don't believe Uncle Sam you haven't any faith in yourself! MORAL: INVEST IN ALL THE LIBERTY BONDS YOU POSSIBLY CAN.

Discouraging Trade Papers

THE new postal rates, establishing mailing zones and heavily increasing second-class mail charges, go into effect on July 1.

The Welding Engineer believes that the new regulations will be harmful not only to American publishers but to all American business, including the supreme business of making war in the most vigorous and the shortest manner.

We feel so sure that we are right about this matter that we are impelled to urge the Congress at least to postpone this experiment in postal regulation until the close of the war.

If this experiment should prove disastrous, as many clear-thinking men are confident it will prove, then by all means let us have the mischief done in a future period of peace and reconstruction and not in this time of stress and of danger when the nation needs to conserve every single ounce of its energies and of its productive power.

The truth is that our opposition to these new postal arrangements going into effect during the war is based wholly upon the reasonable fear that these arrangements will work grave harm to the American press, and upon the firm conviction that no serious injury can be done to the American press without inflicting still more serious and still greater injury upon the business of the country and upon the efficiency of the country's warmaking machinery.

It is simply impossible to overestimate the greatness of the aid which the American press has given to the government in the huge task of mobilizing the resources of the country, both military and economic. It is absolutely correct to say that without the help freely and enthusiastically given by the American press the government could not have succeeded in floating the liberty loans, in selling the millions of war savings stamps, or in putting in operation the machinery of food and fuel conservation.

Without this wonderful help, given so lavishly and with patriotic enthusiasm, the government would have been practically helpless to organize this entirely peaceable nation of ours into an armed and militant nation.

Now, it seems to us very bad business policy to cripple in any way this tremendous machinery which always has been and always will be placed at the disposal of the government without any charge and with the deepest anxiety to fulfill to the utmost the patriotic duty of assisting and upholding the government in its just war.

It seems to us that to decrease the circulation and hinder the production of the press of the United States is as poor policy as it would be to decrease the number of our ships or the output of our munitions factories or to cripple any other part of the machinery of national production.

Really, the thing seems to us preposterous. We cannot find words too earnest or too expressive of anxiety and concern with which to urge upon the administration and the Congress the postponement of this dangerous policy, at least until the end of the war.

In our neighbor country, Canada, the government has adopted an exactly opposite policy. The government has fully realized the vital importance of the assistance given by the Canadian press, and by way of grateful acknowledgment has REDUCED THE POSTAGE RATE upon Canadian publications 50 per cent during the period of the war.

Canadian second-class mail rates were formerly one cent per pound, while ours were one cent per pound, and the former rate of one-half cent per pound has been reduced by the Canadian government to one-quarter cent per pound.

Nor are these rates limited to the boundaries of Canada. They apply to publications sent from Canada to any of the British possessions.

(*Continued from Page 25*)

[illegible] weighed fourteen tons, and would have cost the [illegible]uring concern twenty-eight hundred dollars, and a [illegible]nths' delay to replace same. In other words, we [illegible]-set up and welded job for just one quarter, seven [illegible] dollars.

W. D. Grant,
Detroit Prest-O-Welding & Cutting Co.

NEW SCHOOL OF WELDING

A [illegible] school of oxy-acetylene welding has been established [illegible] Institute, 1949 West Madison St., Chicago, the super[illegible]sion and instruction being under the direction of the Imperial [illegible] Manufacturing Co., Chicago. The school opened on [illegible]day, April 9th, with a class of twenty students. It is the [illegible] to hold classes every Tuesday and Thursday evenings, [illegible] to 8 p. m.

New classes are being formed and applicants may register [illegible] the Lewis Institute any day or evening, except Sunday. [illegible] course will extend over a period of ten weeks, two evenings [illegible] week, the tuition being $10.00 for the course, each student [illegible]ing for gas used individually, the estimated cost of which is [illegible]. A synopsis of the course follows:

Give outline of the general principle of autogenous welding [illegible] means of the Oxy-Acetylene flame (See page 15 of Hand [illegible]k.)

Explain what *Oxygen* is and how it is obtained commerci[illegible].

Explain what *Acetylene* is and how it is obtained com[illegible]cially.

Tell under what pressures the two gases are furnished [illegible] how this pressure is reduced to the required working [illegible]ssure.

Explain how the gases are conducted to the torch through [illegible]erently colored hose.

Explain how the volume of the gases is regulated by [illegible] valves on the torch.

Explain why the different tips require different press[illegible]es and different volumes of gas and how to obtain them.

Point out that Oxygen is not a combustible gas, that [illegible]xygen alone will not burn and that therefore it is necessary [illegible]gnite the Acetylene gas first and afterwards to admit the [illegible]xygen.

Explain how to start welding and the theory of expan[illegible]n and contraction of metals.

Give outline of the general principle of cutting by means [illegible] Oxygen and with the assistance of the Oxy-Acteylene flame.

Tell about the possibilities and advantages of cutting by [illegible]s method.

Give a short illustration by lighting a Welding torch [illegible] demonstrating the fusing of two strips of metal. Light a [illegible]ting torch and give a demonstration by cutting a few pieces [illegible] steel.

Lesson

Rehearse at the beginning of each lesson by asking questions [illegible]garding the points which have been taught in the preceding [illegible]ssons.

Teach Setting Up of Apparatus. (See page 51 Hand Book.)

Talk on Welding of different kinds on metal under the [illegible]llowing headings: (I prefer to keep the men's interest alive [illegible] talking about actual *Work* before teaching them the proper [illegible]e of Apparatus.")

Cast Iron (See page 33 Hand Book.)
Malleable Iron (See page 38 of Hand Book.)
Steel and Wrought Iron (See page 39 of Hand Book.)
Aluminum (See page 44 of Hand Book.)
Copper (See page 46 Hand Book.)
Brass and Bronze (See page 47 Hand Book.)
Miscellaneous Metals (See page 48 of Hand Book.)

[illegible]ollowing the Imperial Hand Book closely and illustrating by practical demonstration a most thorough and instructive course of lessons may be given.

Call attention to the most important points to be observed for safe operation and preservation of apparatus when starting and finishing operations.

Point out at such times the proper selection of tips and the pressures as marked on tips (see table 22, Hand Book.)

Enumerate Preheating Agencies.

Talk on Cutting of Steel and Wrought Iron, explain why other metals cannot be cut. Give demonstration on different thickness of metal. Explain use of Guide and Circle.

Give short talk on Operation with Oxy-Hydrogen and Three-Way-Gas.

End course by again impressing on Students the necessity of proper care of the Apparatus as explained on pages 16 to 22 of the Imperial Hand Book and lastly present each student with a souvenir copy of the Imperial Hand Book.

Time-table

1st Week—No. 1 to No. 12—Rehearsals and setting up.
2nd Week—No. 13—letters a and b.
3rd Week—No. 13—letter c.
4th Week—No. 13—letter d.
5th Week—No. 13—letters e and f.
6th Week—No. 13—letters g and rehearsals.
7th Week—Cutting.
8th Week—Students should practice on work in which they are not efficient.
10th Week—Practical work on very heavy pieces and special work. Repetitions comprising the whole course.

MR. KENYON'S ARTICLE

Editor:

Referring to Mr. Kenyon's article in your February issue giving a description of one of our repair jobs, permit me to say the broken pile head was made of cast *iron* instead of cast steel.

It is unfortunate Mr. Kenyon did not complete his drawing by the addition of a broken transverse line across the plan portion as that would have permitted a better understanding of the break.

I might add that the above pile head is still giving very satisfactory service and has been used for driving hundreds of heavy piles since it was repaired.

Very truly yours,
Wm. T. Bonner,
Engineer Welded Ship Construction, Chester Shipbuilding Co. Ltd.

CARBON PASTE

Editor:

In your January issue of *The Welding Engineer*, C. C. Fouts Company asked what can be used to preserve threads and holes in metal while welding. Any substance containing an appreciable amount of clay or earthy matter is to some extent fusible, and is liable to adhere to the metal. It may also cause blow holes to form in the metal.

Solid carbon is much more satisfactory, being infusible at any temperature, but it is often difficult to shape it properly, especially where the hole is irregular or threads are to be preserved.

There is, on the market, a preparation known as "Welding Paste" which, at room temperature, is plastic and can be shaped as desired. The application of the preheating flame for a few minutes will bake it into a solid pure carbon mass which retains its original shape, is wholly infusible at any obtainable temperature, and will not stick to the metal or cause blow holes to form in it.

This "Welding Paste" can be obtained from the National Carbon Co., Inc., Cleveland, Ohio.

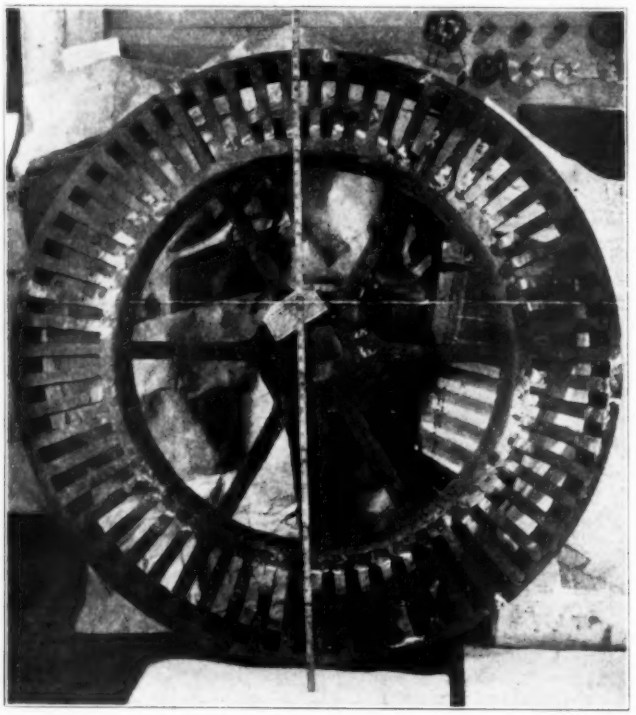
A. S. Bemis,
Experimental Laboratory, National Carbon Co

FIFTY-THREE WELDS.

Editor:

We note in *The Welding Engineer* that you are interested in difficult welding jobs and so we are enclosing photograph of one which we completed a short time ago.

We realize that perhaps this was hardly worth welding,



but our customer requested that we try it and do the best we could with it.

There are 53 welds in all, six of which are in the outer rim and the chalk marks will show to a certain extent where the others were made. One tooth and three inches of the outer rim were lost. Wilkins & Hovey.

PREHEATING

M. K.: The installation of a permanent oven has greater advantage from the point of view of economy of fuel, time and the regularity of the preheating or cooling after welding.

One can build an angle iron frame set with bricks permanently with a partition in the middle. The first chamber is used for preheating by an oil burner or charcoal. After welding, the cylinder is pushed in through a sliding door into the second chamber, that has no grates or air openings, for cooling purposes. Two hinged covers should be provided for both chambers. Editor.

GALVANIZED TANKS

W. O. M.: In reply to your letter of March 20th, we beg to state that it is absolutely necessary to foresee that in the case of welding cast iron, the shapes of the pieces to be welded should have free play of the metal on heating or cooling. If this cannot be arranged with partially heating, then the best method is to slowly preheat the entire casting to redness before welding, with charcoal if possible. After the welding is performed it is just as important to allow a slow cooling in the furnace, until the casting is practically cold.

You cannot weld iron or steel tubes successfully on a galvanized steam boiler, unless all traces of zinc are removed from the entire flue sheet.

If this is not possible, then one can braze the tubes successfully to the flue sheet without removing the zinc.

TRAINING SOLDIER WELDERS

(*Continued from Page 22*)

3. (a) Where is the logical location for the mixing chamber in welding torches employed in automobile and tractor repair work?
   (b) Give reasons for so thinking.
4. How is the torch and the welding treated after repeated "flash-backs" have taken place?
5. Describe briefly the working principles of a regulator and illustrate with a simple sketch.
6. Explain the difference between high and low pressure regulators.
7. (a) Can Acetylene regulators be interchanged with Oxygen regulators with perfect safety? Explain why.
   (b) How is it possible in majority of cases, to distinguish in a very simple manner, between Oxygen and Acetylene regulators, when no gauges are attached?
   (c) Why does this difference exist?
8. (a) Why should all tension upon diaphram springs be removed before admitting gas under pressure to the regulator?
   (b) Can a regulator which has been abused in this manner be repaired?
   (c) What can be employed as a fitting substitute for Galallith?
9. Explain why the high pressure gauge on the Acetylene regulator cannot be used as an index to the contents of the attached cylinder of gas in exactly the same manner as the Oxygen high pressure gauge.
10. Why is glycerine used as a substitute for oil when regrinding torch valve-seats with emery powder, and with Lead-Oxide in the caulking of leaky joints along the line?

LECTURE NUMBER THREE

Subject—Welding of Cast Iron

(Part One)

1. (a) How is it possible to distinguish cast iron from such metals as malleable iron?
   (b) From semi-cast iron?
   (c) From cast steel?
2. (a) What kind metal is used in making "filler-rod" used in the welding of cast iron?
   (b) What general rule can be laid down as to the relation of the metal in the "filler-rod" to the metal to be welded?
3. (a) What are the characteristics of good cast iron "filler-rods"?
   (b) Can piston rings and other small scraps of cast iron be used successfully as "filler-rods"? Explain why.
4. (a) What is the purpose of a flux?
   (b) Is a flux used in the welding of cast iron?
5. (a) Name one formula for making a cast iron flux.
   (b) How often is the flux applied, and by what means?
   (c) In what condition are fluxes kept when not in use?
6. (a) How should the flame be held in the welding of all cast iron?
   (b) When and how is the "filler-rod" added to the weld?
7. (a) Name the one principal cause of blow-holes and hard spots in the weld.
   (b) Mention some of the others.
8. (a) When is it advisable to grind, or "V" out, the ends of the pieces to be welded?
   (b) When is it not advisable?
9. (a) Does the application of heat cause contraction or expansion in metals?
   (b) Are there any excepts to this rule? Name one.
10. (a) Were two cast iron bars measuring 2x12 inches

and ½-inch thick, to be welded, end to end, what precaution should be observed in laying out, if the finished job is to measure just 24 inches long?

(b) In what respect would this problem differ were the bars only 6 inches originally and the finished job to measure 12 inches overall?

(c) Is the action of the metal in the weld a constant, or a variable quantity depending upon the length of the bar in this problem?

LECTURE NUMBER FOUR

Subject—Welding of Cast Iron

(Part Two)

11. (a) How could a spoke, broken midway between the hub and rim, of a 24-inch, 4 spoke wheel (otherwise intact) be welded without preheating? (Use a sketch if necessary to make method clear.)

(b) If a wheel of like size were broken only in the rim, midway between spokes, explain procedure in welding without preheating.

(c) Same sized wheel, broken only in hub;—can weld be made without preheating? Give reasons for so thinking.

(d) Were breaks (a), (b) and (c) all present in same wheel, with rim fracture on opposite side of adjoining spoke from break in hub, should welding started at rim or hub? Why?

12. (a) In the building up of broken or missing teeth in cast iron gears, what procedure is necessary when no carbon blocks are available for forms?

(b) If certain carbon centers from Dry Cell Batteries are obtainable how should they be treated before allowing molten metal to come in direct contact with them?

(c) What very important point must be uppermost in mind when Dental work on gears is being done?

(d) Explain precautions taken in allowing work of this nature to cool.

13. (a) Realizing that hard spots occur in most welds executed by the new welder and having learned the cause of their presence and how to overcome them, would it not be possible to utilize this process for case-hardening parts which were subject to much wear and little strain? Explain procedure.

(b) Why is it necessary to preheat such pieces as the following before the weld is attempted; broken water-jackets on gas engine cylinders, usually brought about by freezing, and holes or cracks in crank cases, caused by the loosening of a connection rod; when lugs on the same cylinder, the arms on the same crank case can be welded without preheating, and oftimes without even dismantling the motor?

LECTURE NUMBER FIVE

Subject—Welding of Cast Iron

(Part Three)

14. Describe fully the manner in which two cast iron bars measuring one by six inches and twenty-four inches long, are welded end to end, citing preparations, precautions and the procedure and materials necessary to execute and carry the weld through to a cool state.

(Note—Both gases are in the line hoses as far as the welding torch.)

LECTURE NUMBER SIX

Subject—Welding of Cast Iron

(Part Four)

15. (a) Are water jackets on cast-iron cylinder blocks welded in a cold, or a preheated condition?

(b) Is this true under all conditions?

(c) If a crack were found in the combustion head of a cylinder block and the entire water jacket and cylinder were cast in one, how should this job be prepared in order to make a successful weld?

(d) In welding a broken lug on the base of a cylinder block how should lug appear after weld is cold?

LECTURE NUMBER SEVEN

Subject—Equipment

1. Describe the operation, step by step, taken to set-up an Oxy-Acetylene Welding plant, from the assembling of the parts, right through, until a neutral welding flame is obtained. (If a sketch, with the gas cylinders and parts numbered 1, 2, 3, etc., will assist in making description clear, it may be used.)

2. (a) Is it desirable to have a planed metal, or a brick top table for welding purposes?

(b) Explain why.

3. Outline and describe briefly, a simple method of building a popular type of welding table.

4. (a) What is the name and style of bricks used in the welding shop?

(b) Name at least three purposes for which these bricks are used.

5. (a) Why does an emery wheel ply such an important part in the Oxy-Acetylene welding industry?

(b) Why is it desirable to have a flexible shaft attachment for the emery wheel, if possible?

(c) Name some of the important things a flexible shaft attachment is used for in the preparation and finishing of welds.

6. (a) In what kind of containers is Retort Cement purchased in the commercial world?

(b) Where is Retort Cement used in the welding shop?

(c) How does it differ from the ordinary clay or putty?

7. (a) Why should a blacksmith forge be added to the welding shop equipment if one is obtainable?

(b) What two important tasks is a forge used for in the welding shop?

8. (a) It is essential that several pails of water be located throughout the shop; why should this be necessary?

(b) Mention a few instances where water is required in the welding shop.

9. Explain fully why great care should be exercised in ventilating a shop where commercial welding is being done.

10. (a) Describe one simple method of constructing a flux box.

(b) What advantages has this type of container?

LECTURE NUMBER EIGHT

Subject—Repairs

1. What is the best method of locating a leak in either the Oxygen or Acetylene lines?

2. If a leak were found in a ground seat, how could it be stopped if the nut on the coupling had been screwed up as far as possible?

3. Name one method of attaching connections to hoses so that they will not blow off or pull off when pressure is applied.

4. How could either an Oxygen or Acetylene hose that had been burned or otherwise injured, be repaired to withstand the gas pressure?

5. How could regulator be operated if the cross-bar for applying pressure upon the diaphram springs were lost?

6. (a) What procedure would be necessary to make connection if cylinder were supplied with an adaptor which would not fit the regulator connection and it could not be coupled up directly?

(b) Realizing that all cylinder connections about a reg-

ulator are generally supplied with a ¼-inch taper pipe thread, why do all manufacturers solder them in?

7. Explain why Oxygen high pressure gauges are constructed with a loose back and a solid front.

8. (a) Where is the first place to seek trouble in a gauge if it leaks?
(b) Can such leaks be repaired?
(c) Describe method.

9. If either a high or low pressure gauge were injured beyond the repair state how could welding plant be kept in operation without it?

10. (a) What would be the trouble, in shutting off a welding plant, if there were a reading on the high pressure gauge and none on the low pressure gauge, after permitting gas to escape from the hose?
(b) How could the reading on this gauge be brought back to zero?

LECTURE NUMBER NINE

Subject—Steel Welding

(Part One)

1. (a) Is the welding of steel more or less difficult than cast iron?
(b) Explain why.

2. (a) Why is the choice of the welding tip so important when working on steel?
(b) What will result if the tip is too large?
(c) If too small?

3. (a) Why is the choice of a "filler-rod" of a correct size so important for steel welding?
(b) What will happen if the "filler-rod" is too large?
(c) If too small?

4. (a) What kind of a "filler-rod" is used in welding steel?
(b) Give a general rule covering relation of "filler-rod" to the metal being welded in all cases, but one or two.
(c) Name one exception.

5. (a) Is a flux (or scaling powder) necessary in welding steel?
(b) Explain why.

6. (a) How is the flame adjusted for steel welding?
(b) What kind of a flame is generally used in finish-steel work?
(c) Why is this done?

7. (a) How is the flame held when executing a steel weld?
(b) How is the "filler-rod" held when making a steel weld?

8. (a) Is it necessary to "V" out on steel the same as on cast iron?
(b) Explain why.

9. (a) Is a steel weld as strong as the original metal if not built up?
(b) Explain why.

10. (a) Is the same provision made for expansion and contraction on steel as on cast iron?
(b) Give reasons for so thinking.

LECTURE NUMBER TEN

Subject—Steel Welding

(Part Two)

11. (a) What is meant by a "Crater" in steel welding?
(b) How are they removed from the weld?

12. (a) What are some methods and marks of distinguishing steel from other metals?
(b) How is cast steel distinguished from cast iron?

13. (a) Name some of the qualifications of a good "filler-rod" for mild steel welding.
(b) In what manner does the "filler-rod" differ from the alloyed and high carbon steels?

14. (a) In bringing the neutral flame in contact with the metal on a steel weld, should the cone be used and spread on the surface, or just lick it?
(b) Explain why.

15. (a) What is the principal cause for hard spots in steel welds?
(b) What causes some of the others?

16. (a) Is it rolled steel or cast steel that does not expand when heated?
(b) Name one other metal that does not expand when heated.

17. (a) Why are welds more difficult on sheet iron and steel than on some of the heavier pieces?
(b) What can be used as a "filler-rod" on sheet metal work?

18. (a) What difficulty is generally encountered when making a long weld like on a steel tank?
(b) How can this be overcome?
(c) Why do the open ends on sheet steel welds overlap in welding when same class of work on cast iron separates?

19. (a) What causes steel welds to carbonize?
(b) What usually causes a burnt steel weld?

20. Describe fully how a broken automobile frame can be welded and re-inforced to make it stronger than originally.

LECTURE NUMBER ELEVEN

Subject—Steel Welding

(Part Three)

21. (a) What kind of a "filler-rod" is used in welding cast steel?
(b) Is a flux used?

22. (a) What kind of a "filler-rod" is employed when welding cast iron to steel?
(b) What kind of a flux is used?

23. (a) Can springs be successfully welded?
(b) State reasons.

24. (a) Why are crank-shaft welds so hard to execute successfully?
(b) What kind of a "filler-rod" is used for best results on most crank-shafts?
(c) What points does the welder consider when deciding whether a weld of this nature is advisable?

25. (a) Briefly describe the method of building up crank-shaft bearings that have been worn down.
(b) What are some of the precautions taken in work of this kind?

26. (a) When automobile propeller shafts and rear axles break, it is generally adjoining the square end. Is it advisable to weld this short piece on?
(b) What is the correct procedure in a case of this kind?

27. (a) If a case-hardened ring-gear is to have its teeth built up or new ones added, how is it handled after welding?
(b) Should all case-hardened work be so treated after welding?

28. (a) In welding two pieces of metal, one of which is considerably lighter than the other, how is the flame held in order to bring both pieces to a fusion at the same time?

29. (a) If a steel weld were to break in the line of weld, how should it be prepared if it is to be rewelded?
(b) Does this procedure apply only to steel?

30. Were a hole 6 inches square in a sheet of steel to be welded up without preheating, what would be the approximate size of the patch necessary and how would it be prepared, in order to take care of the expansion and contraction strains?

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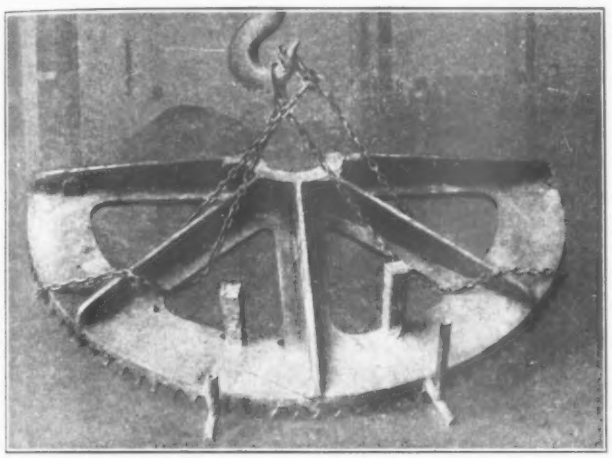
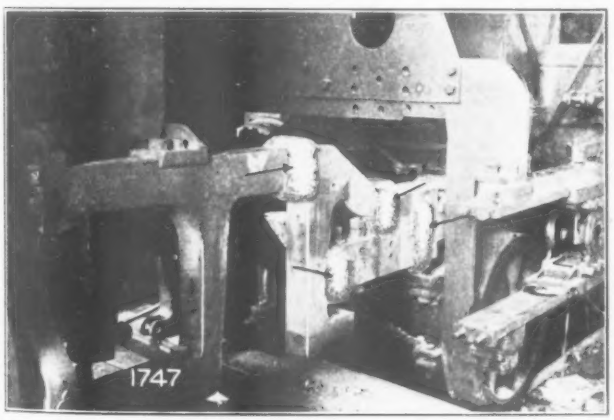


Large bevel gear on which two new teeth and crack have been repaired.



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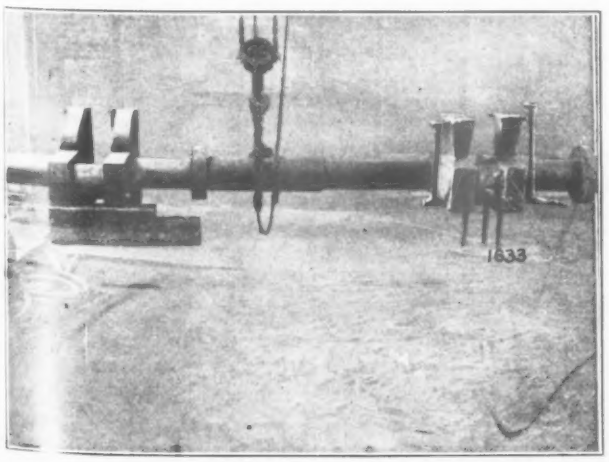

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LECTURE NUMBER TWELVE

Subject—Steel Welding

(Part Four)

31. (a) Why should a steel weld of any kind be executed as rapidly as possible?
    (b) What will happen if steel is kept in a heated condition too long?
    (c) Why should a change be in evidence under these conditions?
32. (a) Explain what is meant by a "dished" patch, for boiler or thin armor plate?
    (b) Draw such a patch.
    (c) How is a patch of this nature prepared?
33. (a) What is meant by a "corrugated" patch for boiler or thin armor plate?
    (b) Sketch such a patch.
    (c) How is this kind of a patch prepared?
34. (a) What advantages has a "corrugated" patch over one that is "dished"?
    (b) Where are "corrugated" patches used extensively?
35. (a) How are boiler flues prepared for re-tiping?
    (b) Sketch a simple jig for holding such pieces in place for welding.
36. (a) Describe how lengths of various sized pipe can be welded together end to end.
    (b) What precautions are necessary when executing such welds?
37. (a) When welding large steel castings why is it almost always advisable to preheat the work?
    (b) Why is preheating so necessary on vanadium and other alloyed steels?
38. Why is it desirable to chip out the sand and thin scale formations, in and around blow-holes in steel castings before filling in?
39. (a) Why do the majority of good welders bend their steel "filler-rods" at right angles about six inches from the end?
    (b) Why isn't this being done on cast iron?
40. (a) What advantage is there in making a vertical weld from the top down, rather than starting from the bottom and working up?
    (b) In welding overhead why it is so important that the work be in a molten state before adding the "filler-rod"?
    (c) In overhead welding, why doesn't the metal drop when in a moltenstate?

LECTURE NUMBER THIRTEEN

Subject—Oxy-Acetylene Cutting

1. Explain fully which parts of an Oxy-Acetylene Cutting plant are different from a welding unit.
2. (a) If there is a difference in either of the regulators mention which one it is.
   (b) What is the difference?
   (c) Why is it necessary?
3. (a) Is it possible to weld with a cutting torch?
   (b) What precaution is necessary if this is done?
   (c) Why isn't this process used?
4. Explain how cutting can be done with the welding torch if necessary.
5. (a) In cutting by the Oxy-Acetylene process, which does the cutting, the oxygen jet or the neutral flame?
   (b) What action has the oxygen jet on the metal?
   (c) What part does the neutral flame play in cutting?
6. Can Oxygen or Acetylene under sufficient pressure be made to cut individually? Explain fully.
7. Why is it specially important that armored hose be used on the oxygen line when making heavy cuts? (Give at least two reasons.)
8. (a) How is a cutting torch lighted? Describe in detail.
   (b) How is cut started on metal?
   (c) How is torch held in regard to metal being cut?
9. (a) Is it possible to successfully cut cast iron?
   (b) Wrought iron?
   (c) Cast steel?
   (d) Rolled steel?
10. (a) Cutting can be done under water with ordinary cutting apparatus; why doesn't the flame go out when submerged?
    (b) What additional equipment is generally used in underwater cutting?

LECTURE NUMBER FOURTEEN

Subject—Brass Welding

1. Explain as fully as possible the chief characteristics of a good "filler-rod" for brass welding.
2. (a) Is a flux used in welding brass?
   (b) What is one way of making a good flux for brass?
3. (a) What kind of a flame is used in brass welding?
   (b) Why?
4. (a) In what position is the flame held in welding brass?
   (b) How should the "filler-rod" be held?
5. (a) Is it advisable to "V" out or burn off the ends of brass work to be welded?
   (b) Explain why.
6. (a) What causes the dense white fumes to appear when fusing brass?
   (b) What is cause of brass welds being porous?
7. Why should brass work not be disturbed when red hot?
8. What is the most difficult part of brass welding as a whole?
9. Why are brass welds generally cooled in water as as soon as fusion is completed?
10. Why is it difficult for the beginner to weld heavy pieces of brass?

LECTURE NUMBER FIFTEEN

Subject—Welding of Malleable Iron

1. (a) Can malleable iron be successfully welded?
   (b) What is the most successful method of joining two pieces of malleable iron?
2. (a) What are three methods of detecting malleable iron?
3. (a) What kind of "filler-rod" is used on malleable iron?
   (b) Are "filler-rod" of malleable iron satisfactory?
   (c) What kind of flux is used on malleable iron work?
4. (a) How is a malleable iron casting prepared for welding?
   (b) How hot should work be, previous to adding "filler-rod"?
   (c) What will occur if too much heat is applied?
5. (a) In what respect does the adjustment of the flame differ on malleable iron from that of cast iron and steel?
   (b) How is the flame held in relation to the work?
   (c) Does the flame come in direct contact with the "filler-rod"?
6. (a) Is more, or less, surface covered by the "filler-rod" on malleable iron than on cast iron?
   (b) Why?
7. (a) How should malleable iron be cooled?
   (b) Is this the same as in welding brass?
8. On what part of machinery does a welder generally expect to find malleable iron castings?
9. Explain carefully how a malleable iron automobile, axle or transmission, housing that has been cracked or broken, can be re-enforced so that it will be stronger than ever.
10. Describe very briefly how malleable iron is made and in what respect it differs from cast iron when cold, and also when under the influence of the oxy-acetylene flame.

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LECTURE NUMBER SIXTEEN

Subject—Carbon Burning

1. (a) Explain what is meant by carbon burning.
   (b) In what respect is it used extensively?
2. (a) Will oxygen gas burn alone or does it merely aid combustion?
   (b) Will carbon in a free state burn?
3. (a) Why is it advisable to remove only the spark plugs and not the entire valve cap or "bonnet" when burning carbon in a gas engine?
   (b) Can it be done either way?
4. (a) Does it make a difference if the carbon is hard and dry in the cylinder?
   (b) What will help in such cases?
5. (a) If the cylinder is rather oily does this make a difference?
   (b) Does the presence of oil aid or retard combustion?
6. (a) What precautions are necessary before carbon burning is attempted?
   (b) How is asbestos paper used in carbon burning?
   (c) Name a good substitute for asbestos paper when carbon burning.
7. (a) Is there any danger of warping the valves and overheating the cylinder and piston when burning carbon?
   (b) What is the effect of carbon burning on aluminum pistons?
8. (a) What pressure is used on the oxygen line for carbon burning?
   (b) Will carbon burning regrind valves?
9. (a) How long should the burning be done?
   (b) How often is carbon burning recommended for a gas engine?
   (c) If there are any carbon particles or sand left in the cylinder after burning is done, how are they removed?
10. Describe how the carbon is removed from a four-cylinder engine, paying particular attention to details, such as lighting, which part of the head the torch is played on first, what does the burning and where the carbon goes.

LECTURE NUMBER SEVENTEEN

Subject—Preheating Agencies

1. (a) What is meant by preheating as applied to the oxy-acetylene welding industry?
   (b) What are several fuels which can be used very successfully for preheating?
2. Name the three principal reasons why parts to be welded are generally preheated.
3. (a) Why is charcoal considered the best preheating agent for general welding?
   (b) Why should it not be used to any great extent in closed rooms during the winter months?
   (c) If used during the winter what precautions are observed?
4. (a) Mention two materials which are used extensively for building up ovens and doing the preheating.
   (b) What kind of brick is used?
5. (a) How much should cast iron be preheated?
   (b) Brass or bronze?
   (c) Aluminum?
6. Sketch and describe how a temporary brick preheating oven should be built, giving all dimensions, should as: length, width and height and reasons for them.
7. Explain how a cylinder block with a broken water jacket is set up for preheating: how oven is built for charcoal fire: how fire is started: how block is protected while welding and how it is returned to a cold state.
8. (a) What precautions are necessary in setting up and preheating aluminum?
   (b) If piece is to be turned while in the fire what provision is made in building up oven?
9. In which cases is preheating absolutely necessary in order to make a satisfactory weld?
10. (a) Give a sketch showing a preheating torch for use on illuminating gas and compressed air, which can be constructed very easily.
    (b) Why are preheating torches not popular for general welding?
    (c) Where are they used in numbers?

LECTURE NUMBER EIGHTEEN

Subject—Aluminum Welding

(Part One)

1. (a) Is the welding of aluminum, more or less difficult than such metals as cast iron and steel
   (b) Explain why?
2. (a) Name the two methods of making aluminum weld.
   (b) Can they be combined?
   (c) Why?
3. (a) What kind of a "filler-rod" is used in welding aluminum?
   (b) Is a flux used? Why?
4. (a) Is a cast or drawn "filler-rod" preferred?
   (b) Name the two important metals which should be present and the percentage of each in the "filler-rod."
5. (a) How should the flame be adjusted for aluminum welding?
   (b) How is the flame held in relation to the work?
6. (a) How is the "filler-rod" added?
   (b) In what respect does this differ from all other metals?
   (c) Why can this be done?
7. (a) Name the principal characteristics of aluminum with regard to heat.
   (b) What other metal acts in a similar manner?
8. (a) Is it necessary to "V" out aluminum for the same reasons as other metals?
   (b) Explain why.
9. (a) Will an aluminum welding be as strong as the original?
   (b) Give reasons.
10. (a) What kind of a tool is used to aid in making an aluminum weld by most welders?
    (b) How is such a tool made?

LECTURE NUMBER NINETEEN

Subject—Aluminum Welding

(Part Two)

11. (a) What kind of files are used to finish aluminum welds?
    (b) In what respect do they differ from the ordinary kind?
12. (a) In which hand is the welding torch held in aluminum work?
    (b) In which, the "filler-rod?"
    (c) The puddle stick?
13. (a) What materials are used to "back-up" aluminum work for preheating?
    (b) Describe fully how aluminum is "backed-up" previous to preheating, in order to prevent the collapse of metal while welding.
14. (a) How quick does the heavy coating or aluminum oxide form on a clean hot piece of aluminum
    (b) Will the metal flow together when this oxide is present?
    (c) How is it overcome?
15. (a) Is it advisable to weld aluminum from one side only or from both sides?
    (b) Why?
16. (a) In preheating aluminum with charcoal, what precautions are taken in setting-up: in starting the fire

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during the welding operation, and in cooling the piece?

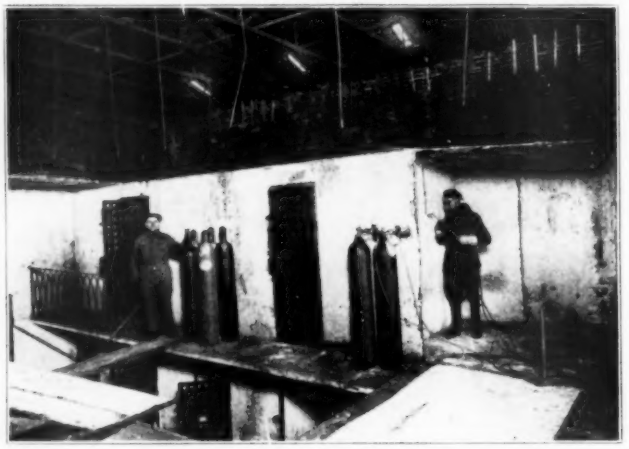
17. (a) Are preheating torches played directly on aluminum work?
    (b) What kind of an oven is used?
18. (a) Is it necessary to heat the whole of an aluminum crank case if one part has to be preheated?
    (b) Give reasons.
19. (a) Are clamps used to hold parts in place on preheated aluminum?
    (b) Explain why.
20. When starting to weld a cold piece of aluminum, the flame is brought in contact with the work and held there much longer than on a similar sized piece of steel before any apparent change occurs. How is this accounted for, knowing that aluminum has a much lower melting point than steel?

LECTURE NUMBER TWENTY

Subject—Aluminum Welding

(Part Three)

21. (a) Explain fully why it is necessary to employ greater speed in the welding of aluminum than on any other metal?
22. (a) What is retort cement?
    (b) How does it differ from ordinary clay?
    (c) For what purpose is it used in aluminum welding?
23. (a) When performing an aluminum weld by the puddle system, is the welder dependent upon the flame; the "filler-rod" or the puddle stick, for the fusion of the metal?
    (b) Give explanations.
24. (a) What method of welding is used when executing a vertical weld on aluminum?



Wrecking a Jail with Imperial Oxy-Hydrogen Torch, furnished by the Oxygen Gas Co., Kansas City.

    (b) Why is not the other method used?
    (c) Is the vertical welding of aluminum to be avoided?
25. (a) Can aluminum welds be made overhead?
    (b) Explain why.
26. (a) Is the same method used on aluminum as in cast iron in welding from the closed end, toward the open?
    (b) Is this procedure necessary on preheated work?
27. (a) If a suspension arm, of a "U" type, on an aluminum crank case were to break about three or four inches from the body of the case, could it be welded in place without dismantling the motor?
    (b) Explain in detail how such an arm should be welded.
28. (a) Due to the contraction and expansion, it is very difficult to have the bolt hole, in the end of an aluminum suspension arm that has been welded, return exactly to its former position. How is this difficulty provided for?
29. (a) Should a section of an aluminum crank case be missing; would it be advisable to build up a new part with the "filler-rod" or to cast a new part in a mold and then weld it in?
    (b) Under what conditions should the above be done?

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30. (a) If it were found that an aluminum crank case after being welded, had on corner about 1/8 inch lower than the rest of the case and it had not effected any of the bearings, could it still be reclaimed?
    (b) Give procedure.

The statement of the ownership, management, circulation, etc., required by the act of Congress of August 24, 1912, of The Welding Engineer, published monthly at Chicago, Ill., for April, 1918.

State of Illinois, County of Cook, ss.

Before me, a Notary Public in and for the State and County aforesaid, personally appeared L. B. Mackenzie, who, having been duly sworn according to law, deposes and says that he is the Editor of The Welding Engineer and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:

Publisher: The Welding Engineer Publishing Co., 608 S. Dearborn St.

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Managing Editor: L. B. Mackenzie, 608 S. Dearborn St.

Business Manager: L. B. Mackenzie, 608 S. Dearborn St.

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L. B. MACKENZIE,
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(Seal) Mary L. Kahn

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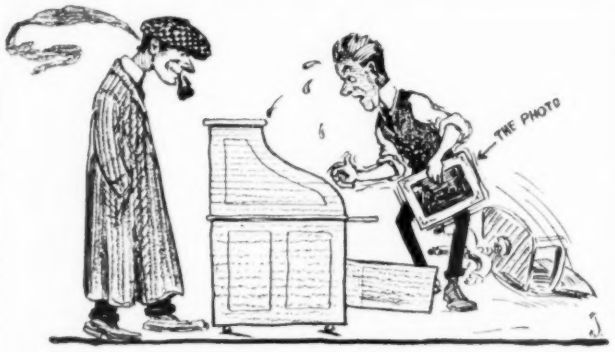

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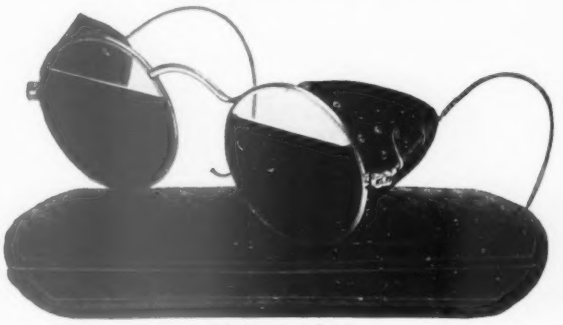

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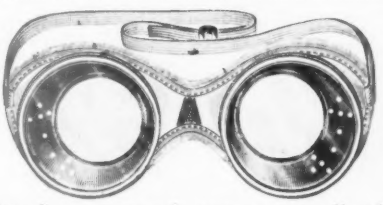

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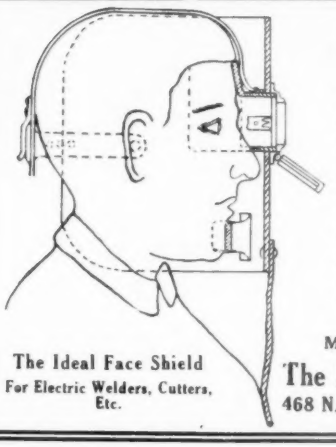

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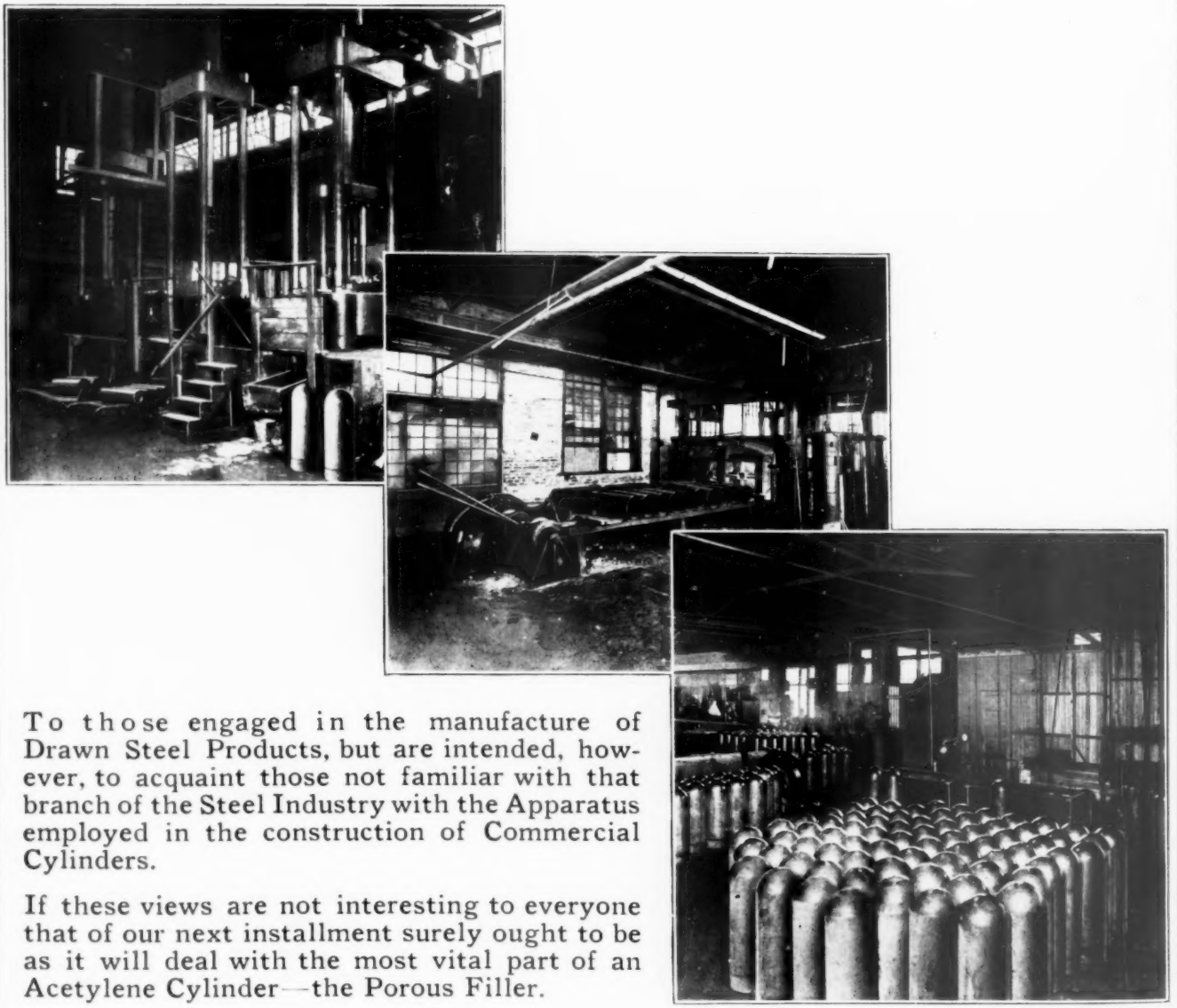

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